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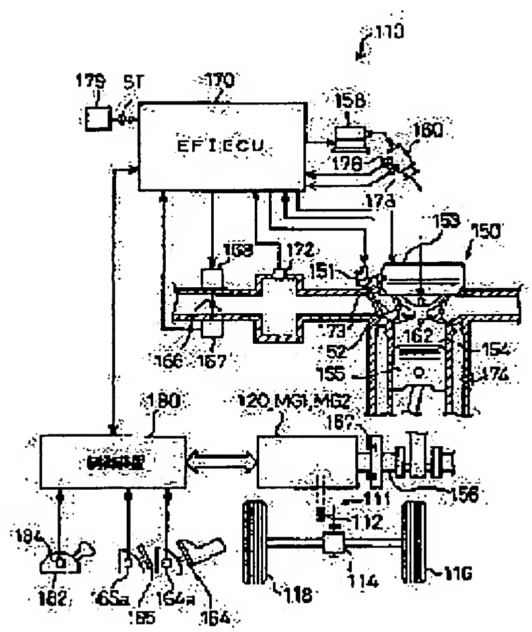
(54) DRIVE UNIT

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce the amplitude of torsional vibration in a crankshaft to be produced at the time of motoring an internal combustion engine by an electric motor mechanically connected to the crankshaft of this engine via damper as well as to make it quickly pass through a revolution area where a resonance phenomenon is induced.
SOLUTION: When an engine is started, first of all, the on-off timing of an inlet valve 152 of this engine 150 is controlled to delay the ignition timing, thereby motoring the engine by a motor MG1 to be mechanically connected to a crankshaft 156 via a damper 157. When this engine 150 exceeds an area where its speed causes a resonance phenomenon, the on-off timing of the inlet valve 152 is put back to the ordinary timing, and control over the fuel supply and ignition of the engine 150 is stated. If the on-off timing of the inlet valve 152 is controlled to delay its ignition timing, an effective compression ratio of the engine 150 becomes reduced, so that the engine 150 is able to be smoothly rotated and driven, and thus the amplitude of torsional vibration in the crankshaft 156 is reducible.



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CLAIMS

[Claim(s)]
[Claim 1] A compression ratio modification means to be a driving gear equipped with the internal combustion engine combined with the output shaft through the damper, and the motor which has the revolving shaft combined with this output shaft and the machine target, and to change said internal combustion engine's effective compression ratio, An operational status detection means to detect said internal combustion engine's operational status, and when a predetermined drive demand is received, The motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out, When the operational status detected by said operational status detection means in the midst of motoring by this motor control means is the operational status of the predetermined range, A driving gear equipped with the compression ratio control means which controls said compression ratio modification means as compared with the time of the operational status outside this predetermined range so that said internal combustion engine's effective compression ratio becomes low.
[Claim 2] Said compression ratio modification means is a driving gear according to claim 1 which is a means to adjust the closing motion timing of an internal combustion engine's inlet valve.
[Claim 3] An operational status detection means to be a driving gear equipped with the internal combustion engine combined with the output shaft through the damper, and the motor which has the revolving shaft combined with this output shaft and the machine target, and to detect said internal combustion engine's operational status, It has the motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out, when a predetermined drive demand is received. Said motor control means The driving gear which is the means which carries out drive control of said motor as compared with the time of the operational status outside this predetermined range so that said internal combustion engine's output shaft may rotate with big angle-of-rotation acceleration when the operational status detected by said operational status detection means is the operational status of the predetermined range.
[Claim 4] When the operational status which was the driving gear of a publication 3 either, and was detected by said operational status detection means claim 1 thru/or after receiving the demand of starting of said internal combustion engine turns into predetermined operational status, It has a start-up means to start the fuel supply to said internal combustion engine, and ignition, and to start operation of this internal combustion engine. Said predetermined drive demand Said predetermined range is a driving gear which is the range included by the range until it is a starting demand of said internal combustion engine and initiation of said internal combustion engine's motoring to said internal combustion engine's operational status results in said predetermined operational status.
[Claim 5] Claim 1 thru/or when it is the driving gear of a publication 3 either and the deactivate request of operation of said internal combustion engine is received, It has a fuel supply interruption means to suspend the fuel supply to this internal combustion engine in advance of motoring of this internal combustion engine by said motor control means. Said predetermined drive demand It is the driving gear which is the range when the operational status detected by said operational status detection means turns into predetermined operational status, until it is the deactivate request of operation of said internal combustion engine, and said internal combustion engine stops said predetermined range from from.
[Claim 6] There is no claim 1 which is the range including the range where the system which consists of said internal combustion engine, said damper, and said motor serves as a resonance field of torsion, and said predetermined range is the driving gear of a publication 5 either.
[Claim 7] When it is a driving gear equipped with the internal combustion engine combined with the output

shaft through the damper, and the motor which has the revolving shaft combined with this output shaft and the machine target and a predetermined drive demand is received, The motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out, A resonance energy detection means to detect the resonance energy of torsion of a system which consists of said internal combustion engine, said damper, and said motor, and when the this detected resonance energy is beyond a predetermined value, A driving gear equipped with the motoring means for stopping which carries out drive control of this motor so that said internal combustion engine's motoring may be suspended irrespective of drive control of said motor by said motor control means.
[Claim 8] When it is a driving gear equipped with the internal combustion engine combined with the output shaft through the damper, and the motor which has the revolving shaft combined with this output shaft and the machine target and a predetermined drive demand is made, The motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out, the time check which clocks an operational status detection means to detect said internal combustion engine's operational status, and the duration which the this detected operational status continues and is in the operational status of the predetermined range, when the this clocked duration is beyond predetermined time, a means and A driving gear equipped with the motoring means for stopping which carries out drive control of this motor so that said internal combustion engine's motoring may be suspended irrespective of drive control of said motor by said motor control means.
[Claim 9] Said predetermined range is a driving gear according to claim 8 which is the range including the range where the system which consists of said internal combustion engine, said damper, and said motor serves as a resonance field of torsion.
[Claim 10] There is no claim 7 which is a starting demand of said internal combustion engine, and said predetermined drive demand is the driving gear of a publication 9 either.
[Claim 11] When it has claim 1 thru/or three shafts which are the driving gears of a publication 10 either and combine respectively said output shaft, revolving shaft of said motor, and driving shaft mechanically and power is outputted and inputted among these three shafts to any 2 shafts, A driving gear equipped with a 3 shaft type power I/O means to output and input the power which becomes settled based on the this power outputted and inputted to one residual shaft, and the 2nd motor which considers an exchange of power as said internal combustion engine's output shaft, or said driving shaft.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the driving gear with which an internal combustion engine's output shaft and the revolving shaft of a motor were mechanically combined through the damper in detail about a driving gear.
[0002]
[Description of the Prior Art] Conventionally, what consists of the internal combustion engine and two motors which were carried in the hybrid car as this kind of a driving gear is proposed (for example, JP,6-144020,A etc.). With this equipment, an internal combustion engine's output shaft is combined with the revolving shaft of the 1st motor through a damper and the 1st clutch, and the revolving shaft of the 1st motor is combined with the driving shaft mechanically combined with the wheel through the 2nd clutch. The 2nd motor is further attached in this driving shaft. Where engagement of the 2nd clutch is solved, an internal combustion engine is put into operation by carrying out cranking (motoring) with the 1st motor, while he makes the 1st clutch an engagement condition. The power with which after starting is outputted by the internal combustion engine is used for operating the 1st motor as a generator in the state of the clutch of this as, and charging a dc-battery, or is used for outputting the 2nd clutch to a direct-drive shaft as an engagement condition, and making it run a car.
[0003]
[Problem(s) to be Solved by the Invention] The crankshaft which is generally an internal combustion engine's output shaft is an elastic body, and since distribution is unevenly distributed, the mass forms the vibration system of an infinity degree of freedom. Therefore, resonance phenomena will be caused, if the torque fluctuation by the reciprocating motion of the gas explosion in an internal combustion engine or a piston is added and a lifting, and the resonant frequency and forced frequency of a shaft are in agreement in torsional oscillation. If the amplitude of such a torsional oscillation becomes large, an allophone will arise from the gearing of a crankshaft system, or it will wear out, and a crankshaft will start fatigue breaking depending on the case. In order to avoid the problem by the torsional oscillation of such a crankshaft, as the technique of stopping the amplitude of torsional oscillation, various kinds of dampers are proposed and it is used. However, since the effectiveness of stopping the amplitude of torsional oscillation was equipped with a damping function with a special large damper, it produced un-arranging [of having enlarged while the number of components increases], and the small and simple thing had the problem that the effectiveness was small.
[0004] Although above-mentioned resonance phenomena were based also on the internal combustion engine, since the rotational frequency of a crankshaft arose at the rotational frequency below idle rpm, the many had the problem of producing resonance phenomena, with the equipment which carries out motoring of an internal combustion engine's crankshaft like the above-mentioned conventional example with the motor combined through the damper, when putting an internal combustion engine into operation. Although performing special control (vibration-deadening control) and also making a motor drive to this problem is considered, by this technique, it cannot respond to intentional actuation (for example, sudden halt) of an operator etc. Moreover, although there is also the technique of forming the starter motor which carries out motoring of an internal combustion engine's crankshaft, without minding a damper, by this technique, the number of the motors with which equipment is equipped will increase, and equipment will be enlarged.
[0005] In addition, if such a problem is range which produces resonance phenomena, since it will be generated similarly, the time of suspending an internal combustion engine and the fuel for an internal combustion engine are produced, for example, while rotating the crankshaft with the motor, although it has

stopped.
[0006] The driving gear of this invention sets to make small the amplitude of the torsional oscillation of the output shaft of a prime mover to one of the purposes. Moreover, the driving gear of this invention sets to one of the purposes to pass quickly the operating range of the prime mover which produces resonance phenomena. Furthermore, the driving gear of this invention sets to suspend an internal combustion engine's motoring to one of the purposes, when resonance energy is large.
[0007]
[The means for solving a technical problem, and its operation and effectiveness] With the internal combustion engine with which the 1st driving gear of this invention was combined with the output shaft through the damper A compression ratio modification means to be a driving gear equipped with the motor which has the revolving shaft combined with this output shaft and the machine target, and to change said internal combustion engine's effective compression ratio, An operational status detection means to detect said internal combustion engine's operational status, and when a predetermined drive demand is received, The motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out, When the operational status detected by said operational status detection means in the midst of motoring by this motor control means is the operational status of the predetermined range, Let it be a summary to have the compression ratio control means which controls said compression ratio modification means so that said internal combustion engine's effective compression ratio becomes low as compared with the time of the operational status outside this predetermined range.
[0008] When a predetermined drive demand is received, this 1st driving gear carries out drive control of the motor, as a motor control means carries out motoring of the internal combustion engine by which fuel supply is suspended. A compression ratio control means controls a compression ratio modification means to change an internal combustion engine's effective compression ratio so that an internal combustion engine's effective compression ratio may become low, as compared with the time of being the operational status outside this predetermined range, when an internal combustion engine's operational status detected by the operational status detection means in the midst of motoring by the motor control means is the operational status of the predetermined range. Here, a compression ratio modification means shall be a means to adjust the closing motion timing of an internal combustion engine's inlet valve.
[0009] According to such 1st driving gear, work of compression in an internal combustion engine can be made small by making low an internal combustion engine's effective compression ratio. Consequently, the torque fluctuation which acts on an internal combustion engine's output shaft becomes small, and can make small the amplitude of the torsional oscillation an internal combustion engine's output shaft. Moreover, since the work of compression in an internal combustion engine becomes small, shift of an internal combustion engine's operational status can be made quick, and the operating range which produces resonance phenomena can be passed quickly. In addition, an internal combustion engine's effective compression ratio can be changed by adjusting a means to adjust the closing motion timing of an internal combustion engine's inlet valve for a compression ratio modification means, then an inhalation air content.
[0010] With the internal combustion engine with which the 2nd driving gear of this invention was combined with the output shaft through the damper An operational status detection means to be a driving gear equipped with the motor which has the revolving shaft combined with this output shaft and the machine target, and to detect said internal combustion engine's operational status, and when a predetermined drive demand is received, It has the motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out. Said motor control means When the operational status detected by said operational status detection means is the operational status of the predetermined range, let it be a summary to be the means which carries out drive control of said motor so that said internal combustion engine's output shaft may rotate with big angle-of-rotation acceleration as compared with the time of the operational status outside this predetermined range.
[0011] When the operational status of the internal combustion engine by which the motor control means was detected with the operational status detection means when a predetermined drive demand was received is the operational status of the predetermined range, this 2nd driving gear carries out drive control of the motor as compared with the time of the operational status outside this predetermined range so that an internal combustion engine's output shaft may rotate with big angle-of-rotation acceleration.
[0012] According to such 2nd driving gear, shift of the operational status of the predetermined range can be made quick. Therefore, the operational status of the range which produces resonance phenomena for the operational status of the predetermined range, then the condition of producing resonance phenomena can be

passed quickly.
[0013] When the operational status detected by said operational status detection means in the 1st or 2nd driving gear of these this inventions after receiving the demand of starting of said internal combustion engine turns into predetermined operational status, It has a start-up means to start the fuel supply to said internal combustion engine, and ignition, and to start operation of this internal combustion engine. Said predetermined drive demand It shall be a starting demand of said internal combustion engine, and said predetermined range shall be range included by the range until said internal combustion engine's operational status results [from initiation of said internal combustion engine's motoring] in said predetermined operational status.
[0014] If it carries out like this, it can pass through the resonance field through which it passes at the time of an internal combustion engine's starting quickly, and an internal combustion engine can be put into operation.
[0015] Moreover, when the deactivate request of operation of said internal combustion engine is received in the 1st or 2nd driving gear of this invention, It has a fuel supply interruption means to suspend the fuel supply to this internal combustion engine in advance of motoring of this internal combustion engine by said motor control means. Said predetermined drive demand It shall be the deactivate request of operation of said internal combustion engine, and said predetermined range shall be range until said internal combustion engine stops from from, when the operational status detected by said operational status detection means turns into predetermined operational status.
[0016] If it carries out like this, it can pass through the resonance field through which it passes at the time of a halt of operation of an internal combustion engine quickly, and operation of an internal combustion engine can be suspended.
[0017] Said predetermined range shall be [in / including these modifications / the 1st or 2nd driving gear of this invention] range including the range where the system which consists of said internal combustion engine, said damper, and said motor serves as a resonance field of torsion. If it carries out like this, it can pass through a resonance field quickly more certainly.
[0018] When the 3rd driving gear of this invention is a driving gear equipped with the internal combustion engine combined with the output shaft through the damper, and the motor which has the revolving shaft combined with this output shaft and the machine target and a predetermined drive demand is received, The motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out, A resonance energy detection means to detect the resonance energy of torsion of a system which consists of said internal combustion engine, said damper, and said motor, and when the this detected resonance energy is beyond a predetermined value, Let it be a summary to have the motoring means for stopping which carries out drive control of this motor so that said internal combustion engine's motoring may be suspended irrespective of drive control of said motor by said motor control means.
[0019] When a predetermined drive demand is received, the 3rd driving gear of this this invention carries out drive control of said motor, as a motor control means carries out motoring of said internal combustion engine by which fuel supply is suspended. When the resonance energy of torsion of a system which consists of the internal combustion engine and damper which were detected by the resonance energy detection means, and a motor is beyond a predetermined value, a motoring means for stopping carries out drive control of the motor irrespective of drive control of the motor by the motor control means so that an internal combustion engine's motoring may be suspended. Here, a starting demand of an internal combustion engine is also included in a predetermined drive demand.
[0020] According to the 3rd driving gear of such this invention, since an internal combustion engine's motoring is suspended when resonance energy becomes beyond a predetermined value, it can prevent that more than it and resonance energy become large. Consequently, it is avoidable un-arranging [which it is called the allophone and breakage which may be produced according to resonance phenomena].
[0021] When the 4th driving gear of this invention is a driving gear equipped with the internal combustion engine combined with the output shaft through the damper, and the motor which has the revolving shaft combined with this output shaft and the machine target and a predetermined drive demand is received, The motor control means which carries out drive control of said motor so that motoring of said internal combustion engine by which fuel supply is suspended may be carried out, the time check which clocks an operational status detection means to detect said internal combustion engine's operational status, and the duration which the this detected operational status continues and is in the operational status of the predetermined range, when the this clocked duration is beyond predetermined time, a means and Let it be a

summary to have the motoring means for stopping which carries out drive control of this motor so that said internal combustion engine's motoring may be suspended irrespective of drive control of said motor by said motor control means.
[0022] when the 4th driving gear of this this invention receives a predetermined drive demand, a motor control means carries out motoring of the internal combustion engine by which fuel supply is suspended -- as -- a motor -- drive control -- carrying out -- a time check -- a means clocks the duration which an internal combustion engine's operational status detected by the operational status detection means continues, and is in the operational status of the predetermined range. When this clocked duration is beyond predetermined time, a motoring means for stopping carries out drive control of the motor irrespective of drive control of the motor by the motor control means so that an internal combustion engine's motoring may be suspended. Here, a starting demand of an internal combustion engine is also included in a predetermined drive demand.
[0023] According to the 4th driving gear of such this invention, an internal combustion engine can prevent remaining in the operational status of the predetermined range beyond predetermined time. Therefore, it can prevent remaining in the operational status of the range including the range where the system which consists the predetermined range of an internal combustion engine, a damper, and a motor serves as a resonance field of torsion, then the range where an internal combustion engine becomes a resonance field beyond predetermined time, and can avoid un-arranging [which it is called the allophone and breakage which may be produced according to resonance phenomena].
[0024] It sets also including these modifications to either of the 1st thru/or the 4th driving gear of this invention. When it has three shafts which combine respectively said output shaft, revolving shaft of said motor, and driving shaft mechanically and power is outputted and inputted among these three shafts to any 2 shafts, It shall have a 3 shaft type power I/O means to output and input the power which becomes settled based on the this power outputted and inputted to one residual shaft, and the 2nd motor which considers an exchange of power as said internal combustion engine's output shaft, or said driving shaft.
[0025]
[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained based on an example. Drawing 1 is the block diagram showing the outline configuration of the car carrying the power output unit 110 as an example of this invention. This car is equipped with the engine 150 which outputs power by using a gasoline as a fuel so that it may illustrate. This engine 150 inhales the gaseous mixture of the air inhaled through the throttle valve 166 from the inhalation-of-air system, and the gasoline injected from the fuel injection valve 151 to a combustion chamber 154 through an inlet valve 152, and changes into rotation of a crankshaft 156 movement of the piston 155 depressed by explosion of this gaseous mixture. Here, the closing motion drive of the throttle valve 166 is carried out by the actuator 168. An ignition plug 162 forms a spark with the high voltage drawn through the distributor 160 from the ignitor 158, and gaseous mixture is lit by the spark and carries out explosion combustion of it by it.
[0026] This engine 150 is equipped with the closing motion timing modification device 153 in which the closing motion timing of an inlet valve 152 is changed. This closing motion timing modification device 153 adjusts the closing motion timing of an inlet valve 152 for the phase to the crank angle of the inhalation-of-air cam shaft which carries out the closing motion drive of the inlet valve 152 and which is not illustrated a tooth lead angle or by carrying out a lag. In addition, the tooth lead angle and lag of a phase of an inhalation-of-air cam shaft are performed by the feedback control by the electronic control unit 170 mentioned later based on the signal detected by the cam-shaft position sensor 173 which detects the position of an inhalation-of-air cam shaft.
[0027] Operation of this engine 150 is controlled by the electronic control unit (hereafter referred to as EFIECU) 170. The various sensors in which the operational status of an engine 150 is shown are connected to EFIECU170. For example, they are the throttle-valve position sensor 167 which detects the opening (position) of a throttle valve 166, the inlet-pipe negative pressure sensor 172 which detects the load of an engine 150, the cam-shaft position sensor 173 which detects the position of an inhalation-of-air cam shaft, the coolant temperature sensor 174 which detects the water temperature of an engine 150, the rotational frequency sensor 176 which is prepared for a distributor 160 and detects the rotational frequency and angle of rotation of a crankshaft 156, the angle-of-rotation sensor 178, etc. In addition, although the starting switch 179 which detects the condition ST of an ignition key was connected to EFIECU170 in addition to this, illustration of other sensors, a switch, etc. was omitted.
[0028] It is combined with planetary gear 120, the motor MG 1, and Motor MG 2 which are later mentioned through the damper 157 which controls the amplitude of the torsional oscillation produced in a crankshaft 156, and the crankshaft 156 of an engine 150 is combined with the differential gear 114 through the power

transfer gear 111 which sets a revolving shaft as a driving shaft 112 further. Therefore, finally the power outputted from the power output unit 110 is transmitted to the driving wheel 116,118 on either side. It connects with the control unit 180 electrically, and a motor MG 1 and a motor MG 2 are controlled by this control unit 180. Although the configuration of a control unit 180 is explained in full detail later, the interior is equipped with Control CPU and accelerator pedal position sensor 164a prepared in the shift position sensor 184 formed in the shift lever 182 or the accelerator pedal 164, brake-pedal position sensor 165a prepared in the brake pedal 165 are connected. Moreover, the control unit 180 is exchanging various information by EFIECU170 and the communication link which were mentioned above. About control including the exchange of such information, it mentions later.

[0029] Drawing 2 is a block diagram which illustrates the power output unit 110 centering on planetary gear 120, a motor MG 1, a motor MG 2, and a control unit 180. The power output unit 110 so that it may illustrate greatly The damper 157 which connects the crankshaft 156 and the carrier shaft 127 of an engine 150 and an engine 150, and controls the amplitude of the torsional oscillation of a crankshaft 156, the planetary gear 120 by which the planetary carrier 124 was combined with the carrier shaft 127, It consists of control units 180 which carry out drive control of the motor MG 2 combined with the ring wheel 122 of the motor MG 1 combined with the sun gear 121 of planetary gear 120, and planetary gear 120, and the motors MG1 and MG2.

[0030] Drawing 3 is the enlarged drawing expanding and showing the parts of the planetary gear 120 of the power output unit 110, a motor MG 1, and a motor MG 2. The sun gear 121 combined with the sun gear shaft 125 in the air with which planetary gear 120 penetrated the shaft center on the carrier shaft 127 so that it might illustrate, The ring wheel 122 combined with the crankshaft 156 and the ring wheel shaft 126 of the same axle, Two or more planetary pinion gears 123 which revolve around the sun while it is arranged between a sun gear 121 and a ring wheel 122 and the periphery of a sun gear 121 is rotated, It consists of planetary carriers 124 which are combined with the edge of the carrier shaft 127 and support the revolving shaft of each planetary pinion gear 123 to revolve. In these planetary gear 120, 3 of the sun gear shaft 125 combined with the sun gear 121, the ring wheel 122, and the planetary carrier 124, respectively, the ring wheel shaft 126, and the carrier shaft 127 shafts are used as the I/O shaft of power, and if the power outputted and inputted among three shafts to any 2 shafts is determined, the power outputted and inputted by one residual shaft will become settled based on the power outputted and inputted biaxial [which was determined]. In addition, the detail about I/O of the power to three shafts of these planetary gear 120 is mentioned later.

[0031] The power fetch gear 128 for the ejection of power is combined with the ring wheel 122. This power fetch gear 128 is connected to the power transfer gear 111 by the chain belt 129, and transfer of power is made between the power fetch gear 128 and the power transfer gear 111.

[0032] A motor MG 1 is constituted as a synchronous motor generator, and is equipped with Rota 132 which has two or more permanent magnets 135 in a peripheral face, and the stator 133 around which the three phase coil 134 which forms rotating magnetic field was wound. Rota 132 is combined with the sun gear shaft 125 combined with the sun gear 121 of planetary gear 120. A stator 133 carries out the laminating of the sheet metal of a non-oriented magnetic steel sheet, is formed, and is being fixed to the case 119. This motor MG 1 operates as a motor which carries out the rotation drive of Rota 132 by the interaction of the field by the permanent magnet 135, and the field formed with the three phase coil 134, and operates as a generator which makes the both ends of the three phase coil 134 produce electromotive force by the interaction of the field by the permanent magnet 135, and rotation of Rota 132. In addition, the resolver 139 which detects the angle-of-rotation thetas is formed in the sun gear shaft 125.

[0033] A motor MG 2 is constituted as a synchronous motor generator like a motor MG 1, and is equipped with Rota 142 which has two or more permanent magnets 145 in a peripheral face, and the stator 143 around which the three phase coil 144 which forms rotating magnetic field was wound. Rota 142 is combined with the ring wheel shaft 126 combined with the ring wheel 122 of planetary gear 120, and the stator 143 is being fixed to the case 119. The stator 143 of a motor MG 2 also carries out the laminating of the sheet metal of a non-oriented magnetic steel sheet, and is formed. It operates as a motor or a generator like [this motor MG 2] a motor MG 1. In addition, the resolver 149 which detects the angle-of-rotation thetar is formed in the ring wheel shaft 126.

[0034] Next, the control unit 180 which carries out drive control of the motors MG1 and MG2 is explained. As shown in drawing 2 , the control unit 180 consists of dc-batteries 194 which are the control CPU 190 and the rechargeable battery which control the 1st drive circuit 191 which drives a motor MG 1, the 2nd drive circuit 192 which drives a motor MG 2, and both the drive circuit 191,192. Control CPU 190 is one chip

microprocessor, and equips the interior with RAM190a for work pieces, ROM190b which memorized the processing program, input/output port (not shown) and EFIECU170, and the serial communication port (not shown) that performs a communication link.
[0035] In this control CPU 190, angle-of-rotation thetas of the sun gear shaft 125 from a resolver 139, The accelerator pedal position AP from angle-of-rotation thetar of the ring wheel shaft 126 from a resolver 149, and accelerator pedal position sensor 164a (the amount of treading in of an accelerator pedal) The brake-pedal position BP from brake-pedal position sensor 165a (the amount of treading in of a brake pedal), The shift position SP from the shift position sensor 184 The remaining capacity of the current values Iu1 and Iv2 from two current detectors 195,196 prepared in the 1st drive circuit 191, the current values Iu2 and Iv2 from two current detectors 197,198 prepared in the 2nd drive circuit 192, and a dc-battery 194 The remaining capacity BRM from the remaining capacity detector 199 to detect etc. is inputted through input port. In addition, what the remaining capacity detector 199 measures the specific gravity of the electrolytic solution of a dc-battery 194 or the weight of the whole dc-battery 194, and detects remaining capacity, the thing which calculates the current value and time amount of charge and discharge, and detects remaining capacity, the thing which detects remaining capacity by making between the terminals of a dc-battery short-circuit momentarily, and measuring sink internal resistance for a current are known.
[0036] Moreover, from control CPU 190, the control signal SW2 which drives six transistors Tr11 as the control signal SW1 which drives six transistors Tr1 which are the switching elements prepared in the 1st drive circuit 191 thru/or Tr6, and a switching element prepared in the 2nd drive circuit 192 thru/or Tr16 is outputted. Six transistors Tr1 in the 1st drive circuit 191 thru/or Tr6 constitute the transistor inverter, two pieces are arranged at a time in a pair, respectively so that it may become a source and sink side to power-source Rhine L1 and L2 of a pair, and each of the three phase coil (UVW) 34 of a motor MG 1 is connected at the node. Power-source Rhine L1 and L2 controls sequentially the rate of the transistor Tr1 which makes a pair by control CPU 190 since it connects with the plus [of a dc-battery 194], and minus side, respectively thru/or the ON time amount of Tr6 with a control signal SW1, and if the current which flows in each coil of the three phase coil 134 is made into a false sine wave by PWM control, rotating magnetic field will be formed with the three phase coil 134.
[0037] On the other hand, six transistors Tr11 of the 2nd drive circuit 192 thru/or Tr16 also constitute the transistor inverter, is arranged, respectively, and the node of the transistor which makes a pair is connected to each of the three phase coil 144 of a motor MG 2. [as well as the 1st drive circuit 191] Therefore, the transistor Tr11 thru/or the ON time amount of Tr16 which makes a pair by control CPU 190 is sequentially controlled with a control signal SW2, and if the current which flows in each coil 144 is made into a false sine wave by PWM control, rotating magnetic field will be formed with the three phase coil 144.
[0038] Actuation of the power output unit 110 of the example which explained the configuration above is explained. The principle of operation of the power output unit 110, especially the principle of torque conversion are as follows. When operating an engine 150 on the operation point P1 of an engine speed Ne and Torque Te and operating the ring wheel shaft 126 on the operation point P2 of an engine speed Nr which is different although it is the same energy as the energy Pe outputted from this engine 150, and Torque Tr, the case where carry out torque conversion and the power outputted from an engine 150 is made to act on the ring wheel shaft 126 is considered. The engine 150 at this time, the rotational frequency of the ring wheel shaft 126, and the relation of torque are shown in drawing 4 .
[0039] According to the place which device study teaches, the relation between the rotational frequency in three shafts (the sun gear shaft 125, the ring wheel shaft 126, and carrier shaft 127) of planetary gear 120 or torque can be expressed as drawing called the collinear Fig. illustrated to drawing 5 and drawing 6 , and can be solved geometrically. In addition, the rotational frequency of three shafts and the relation of torque to planetary gear 120 are also analyzable in formula by calculating the energy of each shaft etc., even if it does not use an above-mentioned collinear Fig. By this example, since explanation is easy, it explains using a collinear Fig.
[0040] The axis of ordinate in drawing 5 is a rotational frequency shaft of three shafts, and an axis of abscissa expresses the ratio of the location of the axis of coordinates of three shafts. That is, when the axes of coordinates S and R of the sun gear shaft 125 and the ring wheel shaft 126 are taken to both ends, the axis of coordinates C of the carrier shaft 127 is defined as a shaft which divides Shaft S and Shaft R interiorly to 1:rho. rho is the ratio of the number of teeth of a sun gear 121 to the number of teeth of a ring wheel 122 here, and it is expressed with a degree type (1).
[0041]
[Equation 1]

$$\rho = \frac{\text{サンギヤの歯数}}{\text{リングギヤの歯数}} \quad \cdots\cdots(1)$$

[0042] The engine 150 is operated at the rotational frequency Ne, since the case where the ring wheel shaft 126 is operated at the rotational frequency Nr is considered, the rotational frequency Ne of an engine 150 can be now plotted on the axis of coordinates C of the carrier shaft 127 combined with the crankshaft 156 of an engine 150, and a rotational frequency Nr can be plotted on the axis of coordinates R of the ring wheel shaft 126. If the straight line which passes along both this point is drawn, it can ask for the rotational frequency Ns of the sun gear shaft 125 as a rotational frequency expressed on the intersection of this straight line and axis of coordinates S. Hereafter, this straight line is called a collinear of operation. In addition, it can ask for a rotational frequency Ns by the proportion equation (degree type (2)) using a rotational frequency Ne and a rotational frequency Nr. Thus, in planetary gear 120, if it opts for any two rotations among a sun gear 121, a ring wheel 122, and the planetary carrier 124, it will opt for one residual rotation based on two rotations for which it opted.
[0043]
[Equation 2]

$$Ns = Nr - (Nr - Ne)\frac{1+\rho}{\rho} \quad \cdots\cdots(2)$$

[0044] Next, the torque Te of an engine 150 is made to act on the drawn collinear of operation upwards from drawing Nakashita by making the axis of coordinates C of the carrier shaft 127 into line of action. Since a collinear of operation can be dealt with as the rigid body at the time of making the force as a vector act to torque at this time, the torque Te made to act on an axis of coordinates C is separable into the torque Tes on an axis of coordinates S, and the torque Ter on an axis of coordinates R with the technique of separation of the force to the line of action with which the sense is the same with line of action and differs. The magnitude of Torque Tes and Ter is expressed by a degree type (3) and the formula (4) at this time.
[0045]
[Equation 3]

$$Tes = Te \times \frac{\rho}{1+\rho} \quad \cdots\cdots(3)$$

$$Ter = Te \times \frac{1}{1+\rho} \quad \cdots\cdots(4)$$

[0046] What is necessary is just to take balance of the force of a collinear of operation, in order for the collinear of operation to be stable in this condition. That is, magnitude is the same as Torque Tes, the torque Tm1 with the opposite sense is made to act, magnitude is the same to resultant force with torque and Torque Ter with the opposite sense on an axis of coordinates R in the same magnitude as the torque Tr outputted to the ring wheel shaft 126, and the sense makes the opposite torque Tm2 act on an axis of coordinates S. This torque Tm1 can act by the motor MG 1, and torque Tm2 can be made to act by the motor MG 2. Since torque is made to act on a rotational direction and the rotational reverse sense by the motor MG 1 at this time, a motor MG 1 will operate as a generator and revives electrical energy Pm1 expressed with the product of torque Tm1 and a rotational frequency Ns from the sun gear shaft 125. By the motor MG 2, since the direction of torque is the same as the direction of rotational, a motor MG 2 operates as a motor and is outputted to the ring wheel shaft 126 by making into power electrical energy Pm2 expressed by the product of torque Tm2 and a rotational frequency Nr.
[0047] Here, if electrical energy Pm1 and electrical energy Pm2 are made equal, all the power consumed by the motor MG 2 can be revived by the motor MG 1, and it can be provided. What is necessary is for that just to make equal the thing which outputs all the inputted energy then the energy Pe outputted from an engine 150 since it is good, and energy Pr outputted to the ring wheel shaft 126. That is, the energy Pe expressed with the product of Torque Te and a rotational frequency Ne and energy Pr expressed with the product of Torque Tr and a rotational frequency Nr are made equal. If it compares with drawing 4 , torque conversion will be carried out and the power expressed with the torque Te outputted from the engine 150 currently operated on the operation point P1 and a rotational frequency Ne will be outputted to the ring wheel shaft 126 as power expressed with the same energy at Torque Tr and a rotational frequency Nr. As mentioned above, the power outputted to the ring wheel shaft 126 is transmitted to a driving shaft 112 by the power fetch gear 128 and the power transfer gear 111, and is transmitted to a driving wheel 116,118 through a differential gear 114. Therefore, since linear relation is materialized for the power outputted to the ring

wheel shaft 126, and the power transmitted to a driving wheel 116,118, it is controllable by controlling the power outputted to the ring wheel shaft 126 in the power transmitted to a driving wheel 116,118.

[0048] Although the engine speed Ns of the sun gear shaft 125 is forward in the collinear Fig. shown in drawing 5 , as shown in the collinear Fig. shown in drawing 6 , it may become negative at the engine speed Ne of an engine 150, and the engine speed Nr of the ring wheel shaft 126. At this time, by the motor MG 1, since the direction of rotational and the direction where torque acts become the same, a motor MG 1 operates as a motor and consumes electrical energy Pm1 expressed by the product of torque Tm1 and a rotational frequency Ns. On the other hand, by the motor MG 2, since the direction of rotational and the direction where torque acts become reverse, a motor MG 2 will operate as a generator and will revive electrical energy Pm2 expressed by the product of torque Tm2 and a rotational frequency Nr from the ring wheel shaft 126. In this case, if electrical energy Pm1 consumed by the motor MG 1 and electrical energy Pm2 revived by the motor MG 2 are made equal, electrical energy Pm1 consumed by the motor MG 1 can be exactly provided by the motor MG 2.

[0049] The above principle of operation explained the conversion efficiency of the power by planetary gear 120, a motor MG 1, a motor MG 2 and a transistor Tr1, or Tr16 as a value 1 (100%). Since it is less than one value in fact, it is necessary to make energy Pr which makes a bigger value a little than the energy Pr which outputs the energy Pe outputted from an engine 150 to the ring wheel shaft 126, or is conversely outputted to the ring wheel shaft 126 into a value [a little] smaller than the energy Pe outputted from an engine 150. For example, what is necessary is just to consider as the value computed by multiplying by the inverse number of conversion efficiency by the energy Pr outputted to the ring wheel shaft 126 in the energy Pe outputted from an engine 150. Moreover, what is necessary is to consider as the value computed from what multiplied the power revived by the motor MG 1 in the condition of the collinear Fig. of drawing 5 in the torque Tm2 of a motor MG 2 by the effectiveness of both motors, and just to compute the power consumed by the motor MG 1 in the condition of the collinear Fig. of drawing 6 from what was broken by effectiveness of both motors. In addition, although energy is lost as heat by machine friction etc. in planetary gear 120, there are very few the amounts of loss, if it sees from the amount of whole, and the effectiveness of the synchronous motor used for motors MG1 and MG2 is very close to a value 1. Moreover, very small things, such as GTO, are known also for a transistor Tr1 thru/or the on resistance of Tr16. Therefore, since it becomes a thing near a value 1, and the following explanation is also easy for explanation, the conversion efficiency of power is dealt with as a value 1 (100%), unless it shows clearly.

[0050] As mentioned above, the actuation which adds the electrical energy stored in the dc-battery 194 to the power outputted from the engine 150 besides the actuation which carries out torque conversion of all the power outputted from such an engine 150, and is outputted to the ring wheel shaft 126 although fundamental actuation of the power output unit 110 was explained, and outputs to a ring wheel shaft 126, the actuation which store a part of power conversely outputted from an engine 150 as electrical energy in a dc-battery 194 are possible.

[0051] Next, the processing at the time of starting of the engine 150 of the power output unit 110 of such an example is explained based on a starting manipulation routine at the time of a halt illustrated to drawing 7 . At the time of this halt, a starting manipulation routine is performed, when the car has stopped and a starting switch 179 is set to ON. As for the control CPU 190 of a control unit 180, activation of this routine sets the closing motion timing of an inlet valve 152 as the predetermined timing by the side of a lag first (step S100). This setup is performed by EFIECU170 which received the setting signal when control CPU 190 transmits a setting signal to EFIECU170 by communication link. That is, it carries out by adjusting to the phase which had the phase of the inhalation-of-air cam shaft which EFIECU170 which received the setting signal does not illustrate set up.

[0052] Then, control CPU 190 controls a motor MG 2 so that the ring wheel shaft 126 will be in a lock condition (step S102). The constant current which can generate the torque of the reverse sense which can oppose the torque is passed in the three phase coil 144 of a motor MG 2 so that the ring wheel shaft 126 may not carry out a rotation drive by the torque which specifically acts on the ring wheel shaft 126 in the case of motoring (cranking) by the motor MG 1 mentioned later. Next, the predetermined torque TST is set as torque command value Tm1* of a motor MG 1 (step S104), and drive control of the motor MG 1 is carried out so that this set-up torque may act on the sun gear shaft 125 with which the motor MG 1 was attached (step S106). Thus, if torque is made to act on the sun gear shaft 125 by the motor MG 1, since the ring wheel shaft 126 is being fixed by the motor MG 2, the torque which acts on the sun gear shaft 125 will act that the gear ratio of (1+rho)/rho is also to the carrier shaft 127 by making the ring wheel shaft 126 into reaction force. Since this torque acts on the crankshaft 156 of an engine 150 through a damper 157, motoring of the

engine 150 will be carried out. In addition, the predetermined torque TST set as torque command value Tm1* of a motor MG 1 is not set up as torque which can rotate the engine 150 by which supply of a fuel is suspended at a predetermined rotational frequency, and was set up by the starting manipulation routine as torque which can rotate an engine 150 at a bigger rotational frequency a little than idle rpm in the condition that the lag of the closing motion timing of an inlet valve 152 is not carried out at the time of a halt of an example.

[0053] Here, specifically, control of the motor MG 1 of step S106 is made by performing the control routine of the motor MG 1 illustrated to drawing 8 . Control of a motor MG 1 is briefly explained using the control routine of drawing 8 . If this routine is performed, control CPU 190 will perform first processing which inputs angle-of-rotation thetas of the sun gear shaft 125 from a resolver 139 (step S120), and will perform processing which searches for the electrical angle theta 1 of a motor MG 1 from angle-of-rotation thetas of the sun gear shaft 125 (step S121). In the example, since the synchronous motor of four pole pairs is used as a motor MG 1, theta1=4thetas will be calculated. Then, processing which detects the currents Iu1 and Iv1 which are flowing to U phase and V phase of the three phase coil 134 of a motor MG 1 with the current detector 195,196 is performed (step S122). Although the current is flowing to the three phase of U, V, and W, since the total is zero, it is sufficient if the current which flows to two phases is measured. In this way, coordinate transformation (three phase -2 phase-number conversion) is performed using the current of the obtained three phase (step S124). Coordinate transformation is changing into the current value of d shaft of the synchronous motor of a permanent-magnet type, and q shaft, and is performed by calculating a degree type (5). Coordinate transformation is performed in the synchronous motor of a permanent-magnet type here because it is an amount with the current of d shaft and q shaft essential when controlling torque. It is also possible to control from the first with a three phase.

[0054]

[Equation 4]

$$\begin{bmatrix} Id1 \\ Iq1 \end{bmatrix} = \sqrt{2} \begin{bmatrix} -\sin(\theta 1 - 120) & \sin\theta 1 \\ -\cos(\theta 1 - 120) & \cos\theta 1 \end{bmatrix} \begin{bmatrix} Iu1 \\ Iv1 \end{bmatrix} \quad \cdots\cdots(5)$$

[0055] Next, after changing into a biaxial current value, processing which asks for current command value Id1* of each shaft searched for from torque command value Tm1* in a motor MG 1, Iq1*, the currents Id1 and Iq1 that actually flowed on each shaft, and deflection, and calculates the electrical-potential-difference command values Vd1 and Vq1 of each shaft is performed (step S126). That is, the following formulas (6) are calculated first and then a degree type (7) is calculated. Here, Kp1, Kp2, Ki1, and Ki2 are multipliers respectively, and these multipliers are adjusted so that the property of the motor to apply may be suited. In addition, the electrical-potential-difference command values Vd1 and Vq1 are calculated from the part (the 1st term of the formula (7) right-hand side) proportional to deflection **I with current command value I*, and an accumulated part (the 2nd term of the right-hand side) of the past of i batch of deflection **I.

[0056]

[Equation 5]

$$\begin{aligned} \Delta Id1 &= Id1^* - Id1 \\ \Delta Iq1 &= Iq1^* - Iq1 \quad \cdots\cdots(6) \\ Vd1 &= Kp1 \cdot \Delta Id1 + \sum Ki1 \cdot \Delta Id1 \\ Vq1 &= Kp2 \cdot \Delta Iq1 + \sum Ki2 \cdot \Delta Iq1 \quad \cdots\cdots(7) \end{aligned}$$

[0057] Then, coordinate transformation (two phase -3 phase-number conversion) equivalent to the inverse transformation of the conversion which performed the electrical-potential-difference command value calculated in this way at step S124 is performed (step S128), and processing which asks for the electrical potential differences Vu1, Vv1, and Vw1 actually impressed to the three phase coil 134 is performed. It asks for each electrical potential difference by the degree type (8).

[0058]

[Equation 6]

$$\begin{bmatrix} Vu1 \\ Vv1 \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos\theta 1 & -\sin\theta 1 \\ \cos(\theta 1 - 120) & -\sin(\theta 1 - 120) \end{bmatrix} \begin{bmatrix} Vd1 \\ Vq1 \end{bmatrix}$$

$$Vw1 = -Vu1 - Vv1 \quad \cdots\cdots(8)$$

[0059] Since actual armature-voltage control is made by the transistor Tr1 of the 1st drive circuit 191 thru/or the on-off time amount of Tr6, it carries out PWM control of each transistor Tr1 thru/or the ON time amount

of Tr6 so that it may become each electrical-potential-difference command value calculated by the formula (8) (step S129).
[0060] If the sense of the torque [in / for the sign of torque command value Tm1* of a motor MG 1 / the collinear Fig. of drawing 5 or drawing 6] Tm1 is made forward here Even if torque command value Tm1* of the same forward value is set up, when the sense on which torque command value Tm1* acts like the condition of the collinear Fig. of drawing 5 differs from the sense of rotation of the sun gear shaft 125, regenerative control is made, and power running control is made like the condition of the collinear Fig. of drawing 6 at the time of the same direction. However, since power running control of a motor MG 1 and regenerative control control the transistor Tr1 of the 1st drive circuit 191 thru/or Tr6 so that forward torque acts on the sun gear shaft 125 by the permanent magnet 135 attached in the peripheral face of Rota 132, and the rotating magnetic field produced according to the current which flows in the three phase coil 134 if torque command value Tm1* is forward, they turn into the same switching control. That is, if the sign of torque command value Tm1* is the same, even if control of a motor MG 1 is regenerative control and it is power running control, it will become the same switching control. Therefore, all of the regenerative control and power running control by control processing of the motor MG 1 of drawing 8 can be performed. Moreover, since the direction of change of angle-of-rotation thetas of the sun gear shaft 125 read at step S120 only becomes reverse when torque command value Tm1* is negative, control processing of the motor MG 1 of drawing 8 can also perform control at this time.
[0061] Motoring (cranking) of the engine 150 is carried out by control of the above motor MG 1. Drawing 9 is an explanatory view which illustrates the relation between the closing motion timing of an inlet valve 152, and the compression torque of an engine 150. Among drawing, Curve A plots a crank angle for the compression torque of the engine 150 made into the usual closing motion timing not to carry out [a tooth lead angle or] closing motion timing of an inlet valve 152 as an axis of abscissa, and Curve B plots a crank angle for the compression torque of the engine 150 which made closing motion timing of an inlet valve 152 the predetermined timing by the side of a lag as an axis of abscissa. If the lag of the closing motion timing of an inlet valve 152 is carried out so that it may illustrate, the effective compression ratio of an engine 150 will become low, and the amplitude of the compression torque of an engine 150 will become small. This means that the smooth rotation drive of the crankshaft 156 can be carried out while meaning that the amplitude of the torsional oscillation produced in a crankshaft 156 by carrying out the lag of the closing motion timing of an inlet valve 152 can be made small. Therefore, a crankshaft 156 makes a rotational frequency rise smoothly in the condition that the amplitude of torsional oscillation is small, in an example. In addition, the collinear Fig. in the motoring condition by this motor MG 1 is shown in drawing 10 .
[0062] If it returns to a starting manipulation routine at the time of a halt of drawing 7 and a motor MG 1 is controlled by step S106, the rotational frequency Ne and threshold N1 which inputted and (step S108) inputted the rotational frequency Ne of an engine 150 are compared continuously (step S110). Here, a threshold N1 is set up as a bigger value than the upper limit of the rotational frequency field where the system combined with the crankshaft 156 combined by the damper 157 and the carrier shaft 127 produces resonance phenomena. In addition, the engine speed Ne of an engine 150 can be inputted by receiving from EFIECU170 what was detected by the engine-speed sensor 176 prepared for the distributor 160 as information on an engine speed Ne by communication link. Although the engine speed Ne of an engine 150 is detected by the engine-speed sensor 176, it can also calculate and ask for it using gear ratio from the engine speed Ns of the sun gear shaft 125 detected by others and the resolver 139, and the engine speed Nr of the ring wheel shaft 126 detected by the resolver 149.
[0063] If processing of steps S108 and S110 is repeated and performed and a rotational frequency Ne becomes one or more thresholds N when the rotational frequency Ne of an engine 150 is smaller than a threshold N1, the tooth lead angle of the closing motion timing of an inlet valve 152 will be carried out, and it will be set as the timing at the time of idle rotation (step S112). And again, the rotational frequency Ne of an engine 150 is inputted (step S114), and processing of steps S114 and S116 is repeated until a rotational frequency Ne becomes two or more thresholds N about the inputted rotational frequency Ne as compared with a threshold N2 (step S116). Here, a threshold N2 is set up as a value [a little] smaller than the idle rpm or this rotational frequency of an engine 150. If the engine speed Ne of an engine 150 becomes two or more thresholds N, supply control of the fuel to an engine 150 and the ignition control of an ignition plug 162 will be started (step S118), and this routine will be ended. In addition, supply control of a fuel and ignition control are transmitting a control signal to EFIECU170 by communication link from control CPU 190, and are performed by EFIECU170.
[0064] According to the power output unit 110 of an example explained above, by carrying out the lag of the

closing motion timing of an inlet valve 152 at the time of starting of an engine 150, the effective compression ratio of an engine 150 can be reduced and motoring (cranking) of the engine 150 by the motor MG 1 can be made easy. Consequently, the rotational frequency of the field which produces the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass can be passed quickly. Moreover, since the effective compression ratio of an engine 150 is reduced and the amplitude of the compression torque of an engine 150 is made small, the amplitude of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass can be made small. Consequently, it can be filled and vibration of the car body produced in the case of the resonance phenomena of torsional oscillation and problems, such as generating of a sound and breakage of a crankshaft 156, can be controlled. Moreover, the damper 157 which controls the amplitude of torsional oscillation can be made into the thing of a simple configuration.
[0065] At the time of a halt of an example, in addition, in a starting manipulation routine After making closing motion timing of an inlet valve 152 into the predetermined timing by the side of a lag, motoring of the engine 150 is carried out by the motor MG 1. If the rotational frequency Ne of an engine 150 becomes one or more thresholds N set up as a value exceeding the field of the rotational frequency which produces the resonance phenomena of torsional oscillation, the tooth lead angle of the closing motion timing of an inlet valve 152 will be carried out. Furthermore, although supply control of the fuel of an engine 150 and ignition control were performed when the engine speed Ne of an engine 150 became two or more thresholds N set up near the idle rpm After making closing motion timing of an inlet valve 152 into the predetermined timing by the side of a lag, motoring of the engine 150 is carried out by the motor MG 1. When the rotational frequency Ne of an engine 150 becomes two or more thresholds N set up near the idle rpm, it is good also as what carries out the tooth lead angle of the closing motion timing of an inlet valve 152, and performs supply control of the fuel of an engine 150, and ignition control.
[0066] In the power output unit 110 of an example, while the car is not running, an engine 150 shall be put into operation, but while making it run a car only under the power outputted to the ring wheel shaft 126 from a motor MG 2 where an engine 150 is suspended, also when putting an engine 150 into operation, it can apply. Hereafter, starting processing of the engine 150 in this condition is explained based on a starting manipulation routine at the time of motorised [of drawing 11]. This routine is performed directions of an operator or by inputting the trigger signal of an engine 150 into the control CPU 190 of a control unit 180 based on the detecting signal from the remaining capacity detector 199 which detects the condition BRM of the power output unit 110, for example, the remaining capacity of a dc-battery 194, when it is in the condition the car is running only under the power outputted from a motor MG 2.
[0067] As for the control CPU 190 of a control unit 180, activation of this routine sets the closing motion timing of an inlet valve 152 as the predetermined timing by the side of a lag first (step S130). Then, while adding what broke the predetermined torque TST by gear ratio rho to torque (torque command value) Tr* which should be outputted to the ring wheel shaft 126 and setting up as torque command value Tm2* of a motor MG 2 (step S132), the predetermined torque TST is set as torque command value Tm1* of a motor MG 1 (step S134), and control of a motor MG 1 and control of a motor MG 2 are performed (step S136). And step S138 which is step S108 of a drive manipulation routine thru/or the same processing as S118 at the time of a halt of drawing 7 thru/or processing of S148 are performed, and this routine is ended.
[0068] Here, torque command value Tr* is the desired value of the torque which it is set up by the routine which is not illustrated based on the amount of treading in of the accelerator pedal 164 operated by the operator, and the rotational frequency Nr of the ring wheel shaft 126, and should be outputted to the ring wheel shaft 126, as a result a driving wheel 116,118 by it. Therefore, in case motoring of the engine 150 is carried out by the motor MG 1 by adding and setting up what divided the predetermined torque TST into torque command value Tr* for torque command value Tm2* of a motor MG 2 by gear ratio rho, it can prevent that the torque which should be outputted to the ring wheel shaft 126 by the torque as reaction force produced on the ring wheel shaft 126 is changed. In addition, control of the motor MG 2 of step S136 is performed by the control routine of the motor MG 2 illustrated to drawing 12 . Since the control routine of the motor MG 2 of drawing 12 is completely the same as that of the control routine of the motor MG 1 illustrated to drawing 8 , the explanation is omitted.
[0069] The situation of change of the collinear Fig. at the time of motoring of the engine 150 being carried out by the motor MG 1 is shown in drawing 13 and drawing 14 . Drawing 13 is a collinear Fig. when the car is made into the run state only under the power under which an engine 150 is in a idle state, and is outputted from a motor MG 2, and drawing 14 is a collinear Fig. at the time of the condition that motoring of the engine 150 was carried out by the motor MG 1. In drawing 13 , torque Tm2 is outputted to the ring wheel

shaft 126 from a motor MG 2, a car is in a run state, and an engine 150 is in a idle state. Although the sun gear shaft 125 will be in a rotation condition and Rota 132 of a motor MG 1 is rotating in this condition, since the torque Tm1 of a motor MG 1 is a value 0, as for a motor MG 1, it acts also neither as regeneration nor power running.

[0070] If step S130 of a starting manipulation routine thru/or S136 are performed from this condition at the time of motorised [of drawing 11], a motor MG 1 will output the torque of a value TST to the sun gear shaft 125, and a motor MG 2 will output the torque which added value TST/rho to the value Tm2 to the ring wheel shaft 126. At this time, by adding torque to the sun gear shaft 125, the condition of balance of drawing 13 collapses and the crankshaft 156 of an engine 150 begins to rotate. And the rotational frequency is made to increase until the torque Tm1 outputted to the sun gear shaft 125 will be in the condition of balancing with the amount contributed (torque Tes) to the sun gear shaft 125 of drag force (torque Te), such as a sliding friction of the piston 155 of an engine 150, and work of compression of an engine 150, from a motor MG 1. Since the amount contributed (torque Ter) to the ring wheel shaft 126 of drag force (torque Te) over rotation of an engine 150 balances with the increment (TST/rho) of the torque Tm2 of a motor MG 2, there is no change in the torque outputted to the ring wheel shaft 126.

[0071] Also in case an engine 150 is put into operation to the midst which is considering the car as transit only with the power outputted from a motor MG 2 according to the power output unit 110 of an example explained above By carrying out the lag of the closing motion timing of an inlet valve 152 at the time of starting of an engine 150 The rotational frequency of the field which produces the resonance phenomena of the torsional oscillation which made easy motoring of the engine 150 by the motor MG 1, and made the engine 150 and the motor MG 1 the inertia mass can be passed quickly. Moreover, the amplitude of the torsional oscillation which made the amplitude of the compression torque of an engine 150 small, and made the engine 150 and the motor MG 1 the inertia mass can be made small, it can be filled and vibration of the car body produced in case it is the resonance phenomena of torsional oscillation, and problems, such as generating of a sound and breakage of a crankshaft 156, can be controlled. And since only the part of torque which acts on the ring wheel shaft 126 increases torque command value Tm2* of a motor MG 2 in the case of motoring by the motor MG 1, the torque outputted to the ring wheel shaft 126 cannot be depended on motoring of a motor MG 1, but can be kept constant. Consequently, the fall of the degree of comfort of a car can be prevented.

[0072] Since the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass happen at a rotational frequency lower than idle rpm with the power output unit 110 of an example, Although the lag of the closing motion timing of the inlet valve 152 of an engine 150 was carried out and motoring of the engine 150 was carried out until it became near idle rpm When it exists exceeding the case where the rotational frequency field which resonance phenomena produce contains idle rpm, or idle rpm, it is good also as what performs motoring to which near of the closing motion timing of the inlet valve 152 of an engine 150 was carried out until it becomes a bigger rotational frequency than idle rpm.

[0073] Moreover, although it applied that the resonance phenomena of the torsional oscillation which made the inertia mass for motoring of the engine 150 to be more smoothly carried out by carrying out the lag of the closing motion timing of the inlet valve 152 of an engine 150 and the engine 150, and the motor MG 1 could be controlled in the power output unit 110 of an example on the occasion of motoring at the time of starting of an engine 150, it is good also as what is applied in the case of motoring at the time of a halt of an engine 150. In this case, what is necessary is just to perform the engine shutdown manipulation routine illustrated to drawing 15 , for example. Hereafter, this processing is explained briefly.

[0074] If the engine shutdown manipulation routine of drawing 15 is performed, the control CPU 190 of a control device 180 will set the closing motion timing of an inlet valve 152 as the predetermined timing by the side of a lag first while suspending supply of the fuel to an engine 150 (step S160) (step S162). And the rotational frequency Ne of an engine 150 is read (step S164), and torque command value Tm1* of a motor MG 1 is set up based on the read rotational frequency Ne (step S166). Here, torque command value Tm1* is set up based on the engine speed Ne of the engine 150 by which fuel supply was suspended, because the rapid torque fluctuation in the case of a halt of the fuel supply of an engine 150 is not outputted to the ring wheel shaft 126 as a torque shock. Therefore, in the example, it asks for the relation between a rotational frequency Ne and the torque Tm1 of Motor MG by experiment so that the rotational frequency Ne of an engine 150 may decrease smoothly, it memorizes to ROM190b by making this into a map, and if the rotational frequency Ne of an engine 150 is given, torque command value Tm1* of a motor MG 1 shall be derived using this map. Thus, by setting up torque command value Tm1* of a motor MG 1, motoring of the

engine 150 will be carried out by the motor MG 1.
[0075] Then, add what broke torque command value Tm1* by gear ratio rho to torque (torque command value) Tr* which should be outputted to the ring wheel shaft 126, and torque command value Tm2* of a motor MG 2 is set up (step S168). Control of a motor MG 1 and a motor MG 2 is performed using set-up torque command value Tm1* and Tm2* (step S170), and a rotational frequency Ne is compared with a threshold N3 (step S172). Here, by the control routine of a motor MG 1 which illustrated control of a motor MG 1 to drawing 8 , since control of a motor MG 2 is performed by the control routine of the motor MG 2 illustrated to drawing 12 , since the explanation about these control overlaps, it is omitted. Moreover, a threshold N3 is set up as a value below the lower limit of the engine speed which produces the resonance phenomena mentioned above, and is defined with the property of an inertia mass which consists of an engine 150 and a motor MG 1. Therefore, since what kind of value is sufficient as it as long as a threshold N3 is a value below the lower limit of the rotational frequency which produces resonance phenomena, it is natural. [of it being good also as a value 0, for example]
[0076] When the rotational frequency Ne of an engine 150 is larger than a threshold N3, it judges that it is in the field which still produces resonance phenomena, and the torque control processing S164 in the condition of having set the closing motion timing of an inlet valve 152 as the predetermined timing by the side of a lag, i.e., a step, thru/or processing of S172 are repeated and performed. Thus, even if the engine speed Ne of an engine 150 exists in the field which produces the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass by controlling, since the amplitude of the compression torque of an engine 150 is made into a small thing, it can make small the amplitude of the torsional oscillation of this inertia mass.
[0077] On the other hand, when the rotational frequency Ne of an engine 150 is three or less threshold N, it judges that it passed through the field which produces resonance phenomena, the closing motion timing of an inlet valve 152 is returned to the usual timing (step S174), and a rotational frequency Ne is compared with a threshold N4 (step S176). Here, a threshold N4 is set up as an engine speed of the engine 150 which becomes within the limits by which the torque fluctuation produced when stopping an engine 150 automatically by making torque Tm1 of a motor MG 1 into a value 0 is small, and the torque shock to the ring wheel shaft 126 is permitted, and is defined with the property of an engine 150, the property of a motor MG 1, etc.
[0078] When the rotational frequency Ne of an engine 150 is larger than a threshold N4 Torque control processing in the condition of having judged that the torque shock to the ring wheel shaft 126 still arose, and having set the closing motion timing of an inlet valve 152 as the usual timing, namely, repeat and perform step S164 thru/or processing of S176, and when the rotational frequency Ne of an engine 150 is four or less threshold N While setting a value 0 as torque command value Tm1* of a motor MG 1 (step S178) Command value Tr* of the torque which should be outputted to the ring wheel shaft 126 is set as torque command value Tm2* of a motor MG 1 (step S180), control of a motor MG 1 and control of a motor MG 2 are performed (step S182), and this routine is ended. On the ring wheel shaft 126, a torque shock is not produced by such control.
[0079] Since the closing motion timing of an inlet valve 152 is set as the predetermined timing by the side of a lag when the rotational frequency of an engine 150 exists in the field which produces the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass according to the halt processing of the engine 150 explained above, the amplitude of the compression torque of an engine 150 becomes small, and can make small the amplitude of the torsional oscillation of this inertia mass. Therefore, it can be filled and vibration of the car body produced in the case of the resonance phenomena of torsional oscillation and problems, such as generating of a sound and breakage of a crankshaft 156, can be controlled. And since motoring of the engine 150 is carried out by the motor MG 1, it can prevent the torque shock which may be produced on the ring wheel shaft 126, until the engine speed Ne of an engine 150 becomes four or less threshold N.
[0080] In the halt processing of such an engine 150, when the rotational frequency Ne of an engine 150 became three or less threshold N, closing motion timing of an inlet valve 152 was made into the usual timing, but it is good also considering the closing motion timing of an inlet valve 152 as predetermined timing by the side of a lag until rotation of an engine 150 stops. The processing in this case should just exclude processing of steps S174 and S176 from the engine shutdown manipulation routine of drawing 15 .
[0081] Moreover, although operation of an engine 150 was suspended in the engine shutdown manipulation routine of drawing 15 in the condition of getting into an accelerator pedal 164 and outputting torque to the ring wheel shaft 126 [good as what suspends operation of an engine 150 when the car has stopped] In this

case, since the accelerator pedal 164 is not broken in, a setup of torque command value Tm2* of the motor MG 2 in steps S168 and S180 assigns a value 0 to Tr* in the formula which asks for each torque command value Tm2*, and should just use it for it.
[0082] Next, power output unit 110B as the 2nd example of this invention is explained. Power output unit 110B of the 2nd example is carrying out the same configuration as the configuration of the power output unit 110 of the 1st example. Therefore, the sign same about the same configuration as the power output unit 110 of the 1st example is attached among the configurations of power output unit 110B of the 2nd example, and the explanation is omitted. In addition, unless it shows clearly, the sign used on the occasion of explanation of the 1st example is used in the semantics same as it is.
[0083] In power output unit 110B of the 2nd example, a starting manipulation routine is performed at the time of a halt illustrated to drawing 16 as processing at the time of starting of an engine 150. At the time of this halt, like the 1st example, a starting manipulation routine is performed, when the car has stopped and a starting switch 179 is set to ON. If this routine is performed, the control CPU 190 of a control unit 180 will control a motor MG 2 first so that the ring wheel shaft 126 will be in a lock condition (step S202). And the rotational frequency Ne of an engine 150 is read (step S202), and the read rotational frequency Ne is compared with a threshold N5 (step S204). Here, a threshold N5 is set up as a value more than the upper limit of the engine speed from which the inertia mass which consists of an engine 150 and a motor MG 1 produces resonance phenomena, and is defined with the property of an engine 150, a motor MG 1, etc.
[0084] When the rotational frequency Ne of an engine 150 is five or less threshold N, the predetermined value Ns1 is set as variation **N (step S206), when larger than a threshold N5, variation **N which set up and (step S208) set the predetermined value Ns2 as variation **N is added to target rotational frequency Ns* of the sun gear shaft 125, and new target rotational frequency Ns* is set up (step S210). Here, the predetermined value Ns1 and the predetermined value Ns2 are set up as augend of target rotational frequency Ns* of the sun gear shaft 125, and in the example, they are set up so that it may become larger than the predetermined value Ns2 about the predetermined value Ns1. Therefore, as compared with the time when the direction in case the rotational frequency Ne of an engine 150 is five or less threshold N is larger than a threshold N5, the augend of target rotational frequency Ns* of the sun gear shaft 125 becomes large.
[0085] In this way, if target rotational frequency Ns* of the sun gear shaft 125 is set up, the rotational frequency Ns of the sun gear shaft 125 is read (step S212), torque command value Tm1* of a motor MG 1 will be set up by the degree type (9) using set-up target rotational frequency Ns* and the read rotational frequency Ns (step S214), and a motor MG 1 will be controlled (step S216). The 2nd term of the right-hand side in a formula (9) is a proportional which negates the deflection from target rotational frequency Ns* of a rotational frequency Ns here, and the 3rd term of the right-hand side is an integral term which abolishes steady-state deviation. Thus, by setting up torque command value Tm1* and controlling a motor MG 1, the sun gear shaft 125 can be rotated by target rotational frequency Ns*.
[0086]
[Equation 7]

$$Tm1^* \leftarrow Tm1^* + K1(Ns^* - Ns) + K2\int (Ns^* - Ns)dt \qquad \cdots\cdots(9)$$

[0087] And when step S202 thru/or processing of S218 are repeated and a rotational frequency Ne becomes two or more thresholds N until a rotational frequency Ne becomes two or more thresholds N about the rotational frequency Ne of an engine 150 as compared with a threshold N2 (step S218), fuel supply control and ignition control are started and an engine 150 is put into operation (step S220).
[0088] An example of the situation of change of target engine-speed Ns* of the sun gear shaft 125 when performing a starting manipulation routine at the time of a halt illustrated to such drawing 16 or the situation of change of the engine speed Ne of an engine 150 is shown in drawing 17 . Target rotational frequency Ns* of the sun gear shaft 125 increases by variation **N of the big predetermined value Ns1, and increases from the predetermined value Ns2 by variation **N of the predetermined value Ns2 after that until the rotational frequency Ne of an engine 150 becomes a threshold N5 so that it may illustrate. Now, since the car has stopped, a collinear Fig. will be in the same condition as drawing 10 . Therefore, change of target engine-speed Ns* of the sun gear shaft 125 can be seen as change of target engine-speed Ne* of an engine 150 as linear relation. However, the relation of Ns*:1+ rho=Ne *:rho between target rotational frequency Ns* and target rotational frequency Ne* is.
[0089] If target engine-speed Ne* of an engine 150 is changed and drive control of the motor MG 1 is carried out by changing target engine-speed Ns* of the sun gear shaft 125, the engine speed Ne of an engine 150 will change the some bottom of target engine-speed Ne* from feedback control of the motor MG 1

being carried out so that it may illustrate. In the example, since target rotational frequency Ne* is made to increase by big variation until it exceeds the threshold N5 set up more than the upper limit of the field where the rotational frequency Ne of an engine 150 produces resonance phenomena, the rotational frequency Ne of an engine 150 also becomes large quickly, and it passes through the field which produces resonance phenomena quickly. Although it will overshoot after the engine speed Ne of an engine 150 serves as a threshold N2 when target engine-speed Ne* is made to increase by big variation as it is In the example, since variation **N of target rotational frequency Ns* is made small as a predetermined value Ns2 smaller than the predetermined value Ns1 after the threshold N5, the variation of target rotational frequency Ne* is settled in idle rpm, without the rotational frequency Ne of an engine 150 overshooting.

[0090] According to power output unit 110B of the 2nd example explained above, it can pass through the field which produces resonance phenomena quickly by enlarging variation of target engine-speed Ne* of an engine 150 until it exceeds the upper limit of the field which produces the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass, and carrying out motoring of the engine 150 by the motor MG 1 so that it may become this engine speed. Consequently, it is filled, and vibration of the car body produced in the case of the resonance phenomena of torsional oscillation and problems, such as generating of a sound and breakage of a crankshaft 156, can be controlled, and the damper 157 which controls the amplitude of torsional oscillation can be made into the thing of a simple configuration. And since variation of target engine-speed Ne* of an engine 150 is made small after crossing the field which produces resonance phenomena, overshoot that the engine speed Ne of an engine 150 far exceeds idle rpm can be prevented.

[0091] Next, in power output unit 110B of the 2nd example, where an engine 150 is suspended explains [from a motor MG 2] starting processing of the engine 150 at the time of making it run a car based on a starting manipulation routine at the time of motorised [of drawing 18] only under the power outputted to the ring wheel shaft 126. This routine is also performed directions of an operator or by inputting the trigger signal of an engine 150 into the control CPU 190 of a control unit 180 based on the detecting signal from the remaining capacity detector 199 which detects the condition BRM of the power output unit 110, for example, the remaining capacity of a dc-battery 194, when it is in the condition the car is running like the 1st example only under the power outputted from a motor MG 2.

[0092] When this routine is performed, the control CPU 190 of a control unit 180 At the time of a halt of drawing 16 , first, step S202 of a starting manipulation routine the same step S232 as processing of S214 thru/or processing of S244, Namely, the rotational frequency Ne of an engine 150 is read (step S232). Variation **N is set up according to a rotational frequency Ne (steps S234-S238). The sun gear shaft 125 does a target rotational frequency Ns* setup of using this variation **N (step S240). The rotational frequency Ns of the sun gear shaft 125 is read (step S242), and processing which sets up torque command value Tm1* of a motor MG 1 by the above-mentioned formula (9) (step S244) is performed. Then, what broke torque command value Tm1* set as command value Tr* of the torque which should be outputted to the ring wheel shaft 126 by gear ratio rho is added, it sets up as torque command value Tm2* of a motor MG 2 (step S245), and control of a motor MG 1 and control of a motor MG 2 are performed (step S246). Adding and setting up what broke torque command value Tm2* of a motor MG 2, and broke torque command value Tm1* into torque command value Tr* by gear ratio rho here can prevent that the torque which should be outputted to the ring wheel shaft 126 by the torque as reaction force produced on the ring wheel shaft 126 is changed, in case motoring of the engine 150 is carried out by the motor MG 1. Repeatedly (step S248), when a rotational frequency Ne becomes two or more thresholds N, fuel supply control and ignition control are started and an engine 150 is put into operation, until the rotational frequency Ne of an engine 150 becomes two or more thresholds N about such a step S232 thru/or processing of S246 (step S250).

[0093] An example of the situation of change of target engine-speed Ns* of the sun gear shaft 125 when performing a starting manipulation routine at the time of motorised [which is illustrated to such drawing 18] or the situation of change of the engine speed Ne of an engine 150 is shown in drawing 19 . Since it is in the condition of a collinear Fig. illustrated to drawing 13 while making it run a car only under the power outputted to the ring wheel shaft 126 from a motor MG 2 where an engine 150 is suspended, target rotational frequency Ns* of the sun gear shaft 125 becomes a negative value. Since a starting manipulation routine is performed from this condition at the time of motorised [which is illustrated to drawing 18], drawing 19 differs only in the initial value of target rotational frequency Ns* of the sun gear shaft 125 as compared with drawing 17 .

[0094] Also in case an engine 150 is put into operation to the midst which is considering the car as transit

only with the power outputted from a motor MG 2 according to the starting processing at the time of motorised [which was explained above] Variation of target rotational frequency Ne* of an engine 150 is enlarged until it exceeds the upper limit of the field which produces the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass. By carrying out motoring of the engine 150 by the motor MG 1 so that it may become this engine speed, it can pass through the field which produces resonance phenomena quickly. Consequently, it is filled, and vibration of the car body produced in the case of the resonance phenomena of torsional oscillation and problems, such as generating of a sound and breakage of a crankshaft 156, can be controlled, and the damper 157 which controls the amplitude of torsional oscillation can be made into the thing of a simple configuration. And since variation of target engine-speed Ne* of an engine 150 is made small after crossing the field which produces resonance phenomena, overshoot that the engine speed Ne of an engine 150 far exceeds idle rpm can be prevented.
[0095] Since the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass happen at a rotational frequency lower than idle rpm at power output unit 110B of the 2nd example, Although it was made to pass through the field where variation of target engine-speed Ne* of an engine 150 is enlarged, and the engine speed Ne of an engine 150 produces these resonance phenomena quickly until it exceeded this engine speed When it exists exceeding the case where the rotational frequency field which resonance phenomena produce contains idle rpm, or idle rpm, it is good also as what enlarges variation of target rotational frequency Ne* of an engine 150 until it exceeds these rotational frequencies.
[0096] moreover, in power output unit 110B of the 2nd example Variation of target rotational frequency Ne* of an engine 150 is enlarged until it crosses the field which produces the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass. Although the engine speed Ne of an engine 150 applied the technique of passing through the field which produces these resonance phenomena quickly on the occasion of motoring at the time of starting of an engine 150, it is good also as what is applied in the case of motoring at the time of a halt of an engine 150. In this case, what is necessary is just to perform the engine shutdown manipulation routine illustrated to drawing 20 , for example. Hereafter, this processing is explained briefly.
[0097] As for the control CPU 190 of a control device 180, activation of the engine shutdown manipulation routine of drawing 20 suspends supply of the fuel to an engine 150 first (step S260). Then, the rotational frequency Ne of an engine 150 is read (step S262), and the read rotational frequency Ne is compared with a threshold N6 (step S264). A threshold N6 is set up as a value below the lower limit of the engine speed which produces the resonance phenomena mentioned above, and is defined with the property of an inertia mass which consists of an engine 150 and a motor MG 1. When the rotational frequency Ne of an engine 150 is six or less threshold N, the predetermined value Ns1 is set as variation **N (step S266), when larger than a threshold N6, variation **N which set up and (step S268) set the predetermined value Ns2 as variation **N is subtracted from target rotational frequency Ns* of the sun gear shaft 125, and new target rotational frequency Ns* is set up (step S270). Therefore, when the rotational frequency Ne of an engine 150 is five or less threshold N, as compared with the larger time than a threshold N5, the variation of target rotational frequency Ns* of the sun gear shaft 125 becomes large.
[0098] In this way, if target rotational frequency Ns* of the sun gear shaft 125 is set up, the rotational frequency Ns of the sun gear shaft 125 will be read (step S272). While setting up torque command value Tm1* of a motor MG 1 by the upper type (9) (step S274) Add what broke torque command value Tm1* set as command value Tr* of the torque which should be outputted to the ring wheel shaft 126 by gear ratio rho, and it sets up as torque command value Tm2* of a motor MG 2 (step S276). Control of a motor MG 1 and control of a motor MG 2 are performed (step S278). Such a step S262 thru/or processing of S278 until a torque shock ceases to produce the torque Tm1 of Motor MG on the ring wheel shaft 126 also as a value 0 Namely, when a rotational frequency Ne becomes four or less threshold N repeatedly (step S280) until the rotational frequency Ne of an engine 150 becomes four or less threshold N While setting a value 0 as torque command value Tm1* of a motor MG 1 (step S282) Command value Tr* of the torque which should be outputted to the ring wheel shaft 126 is set as torque command value Tm2* of a motor MG 1 (step S284), control of a motor MG 1 and control of a motor MG 2 are performed (step S286), and this routine is ended.
[0099] Actuation of the halt processing of such an engine 150 turns into actuation which reversed the time-axis of drawing 19 ,. while it becomes the actuation which reversed the time-axis of drawing 17 when the car had stopped and the car is running. In addition, since the accelerator pedal 164 is not broken in, a setup of torque command value Tm2* of the motor MG 2 in steps S276 and S284 assigns a value 0 to Tr* in the formula which asks for each torque command value Tm2*, and should just use it for the what case suspends

operation of an engine 150 when the car has stopped.
[0100] When the engine speed Ne of an engine 150 exists in the field which produces the resonance phenomena of the torsional oscillation which made the engine 150 and the motor MG 1 the inertia mass according to the halt processing of the engine 150 explained above, it can pass through the field which produces resonance phenomena quickly by enlarging variation of target engine-speed Ne* of an engine 150. Consequently, it is filled, and vibration of the car body produced in the case of the resonance phenomena of torsional oscillation and problems, such as generating of a sound and breakage of a crankshaft 156, can be controlled, and the damper 157 which controls the amplitude of torsional oscillation can be made into the thing of a simple configuration. And since motoring of the engine 150 is carried out by the motor MG 1, it can prevent the torque shock which may be produced on the ring wheel shaft 126, until the engine speed Ne of an engine 150 becomes four or less threshold N.
[0101] Next, in power output unit 110B of the power output unit 110 of such 1st example, or the 2nd example, it can judge whether the inertia mass which consists of an engine 150 and a motor MG 1 has produced the resonance phenomena of torsional oscillation by equipping drawing 21 with the resonance judging circuit 200 illustrated as a block diagram. The band pass filter 201 which passes only the frequency domain which produces resonance phenomena from the frequency component of the engine speed Ne of an engine 150 by inputting the engine speed Ne of an engine 150 so that the resonance judging circuit 200 may be illustrated, The integrating circuit 202 which searches for the signal which integrates with the absolute value of the amplitude of the frequency component outputted from the band pass filter 201 [predetermined time], and is equivalent to resonance energy, The signal amplifying circuit 203 which amplifies the signal equivalent to the resonance energy outputted from an integrating circuit 202, the time of the level of the resistance R1 and R2 which creates the comparison signal of a predetermined voltage level from a 5-volt power source, and the signal equivalent to the resonance energy outputted from the signal amplifying circuit 203 becoming larger than the level of a comparison signal -- a low -- it has the comparator 204 which becomes active. The input port of the band pass filter 201 which is the input terminal of this resonance judging circuit 200 is connected with the output port of the control CPU 190 which outputs the rotational frequency Ne of an engine 150, and the output port of the comparator 204 which is the output terminal of the resonance judging circuit 200 is connected to the input port of control CPU 190. For this reason, control CPU 190 will receive the signal showing the resonance energy of an inertia mass which consists of an engine 150 and a motor MG 1 having turned into beyond predetermined energy from the resonance judging circuit 200 by outputting the engine speed Ne of an engine 150 to the resonance judging circuit 200. therefore, when the signal showing resonance energy having turned into beyond predetermined energy from the resonance judging circuit 200 by control CPU 190 is received If the control which prevents the evil by resonance phenomena, for example, the control which suspends the processing which carries out motoring of the engine 150 by the motor MG 1, can also be performed and it carries out like this It can be filled and vibration of the car body produced in the case of the resonance phenomena of torsional oscillation and problems, such as generating of a sound and breakage of a crankshaft 156, can be controlled more certainly.
[0102] The resonance judging manipulation routine illustrated to drawing 22 can also perform control which suspends motoring of the engine 150 by the motor MG 1 when the resonance phenomena of such a torsional oscillation arise. Hereafter, this processing is explained briefly. Activation of the resonance judging manipulation routine illustrated to drawing 22 judges whether the control CPU 190 of a control device 180 has first the rotational frequency Ne which read the rotational frequency Ne of an engine 150 (step S310), and was read between a threshold N7 and a threshold N8 (step S312). A threshold N7 is set up as a value below the lower limit of the field where the inertia mass which consists of an engine 150 and a motor MG 1 produces resonance phenomena, and a threshold N8 is set up as a value more than the upper limit of the field which produces resonance phenomena.
[0103] When there is no rotational frequency Ne of an engine 150 between this threshold N7 and threshold N8, while setting a value 0 as the resonance judging flag F (step S314), a value 0 is set as Counter C (step S316), and this routine is ended.
[0104] On the other hand, when the rotational frequency Ne of an engine 150 is between this threshold N7 and threshold N8 The resonance judging flag F judges whether it is a value 0 (step S318), and when the resonance judging flag F is a value 0 While setting a value 1 as this resonance judging flag F, a value 0 is set as Counter C (steps S320 and S322), and Counter C is incremented when the resonance judging flag F is a value 1 (step S324). And Counter C is compared with a threshold Cref (step S326). Here, a threshold Cref is set up as the maximum of the tolerance of the elapsed time after going into the field to which the rotational frequency Ne of an engine 150 produces resonance phenomena, or a value [a little] smaller than it, and is

defined with the starting frequency of this routine etc. The amplitude of the torsional oscillation of an inertia mass which consists of an engine 150 and a motor MG 1 becomes large in connection with the elapsed time after going into the field to which the rotational frequency Ne of an engine 150 produces resonance phenomena. vibration of the car body which may be produced as a result of resonance phenomena since the amplitude of this torsional oscillation reflects resonance energy -- it is filled, and it becomes remarkable un-arranging, such as generating of a sound and breakage of a crankshaft 156, as the amplitude of torsional oscillation becomes large. Therefore, a threshold Cref is set up so that it may become time amount shorter than the time amount taken to exceed the magnitude in which the amplitude of such a torsional oscillation is permitted in the example. [0105] When Counter C is under the threshold Cref, it judges that the amplitude of torsional oscillation is small, and this routine is still ended, and when Counter C is beyond the threshold Cref, it judges that the amplitude of torsional oscillation becomes large and it becomes that the permission amplitude is likely to be exceeded, and the halt command of an engine 150 is outputted in order to suspend motoring of the engine 150 by the motor MG 1 (step S328).

[0106] According to the resonance judging manipulation routine explained above, it can judge that the amplitude of the torsional oscillation which makes an engine 150 and a motor MG 1 an inertia mass becomes that the permission amplitude is likely to be exceeded. consequently, vibration of the car body which may be produced in the case of resonance phenomena by suspending motoring of the engine 150 by the motor MG 1 based on this judgment -- it can be filled and can prevent un-arranging, such as generating of a sound, and breakage of a crankshaft 156.

[0107] In each example explained above, although PM form (permanent magnet form-ermanent Magnet type) synchronous motor was used for the motor MG 1 and the motor MG 2, if the both sides of regeneration actuation and a powering movement are possible, VR form (adjustable reluctance form; Variable Reluctance type) synchronous motor, a vernier motor, a direct current motor, an induction motor, a superconducting motor, a step motor, etc. can also be used.

[0108] Moreover, in each example, although the transistor inverter was used as 1st and 2nd drive circuits 191,192, an IGBT (insulated-gate bipolar mode transistor; Insulated Gate Bipolar mode Transistor) inverter, a thyristor inverter, an electrical-potential-difference PWM (pulse-width-modulation-ulse Width Modulation) inverter, a square wave inverter (an electrical-potential-difference form inverter, current form inverter), a resonance inverter, etc. can also be used.

[0109] Furthermore, as a dc-battery 194, although Pb dc-battery, a NiMH dc-battery, Li dc-battery, etc. can be used, it can replace with a dc-battery 194 and a capacitor can also be used.

[0110] the power output unit 210 of the modification illustrated to drawing 23 although the crankshaft 156 of an engine 150 shall be connected to planetary gear 120, the motor MG 1, and the motor MG 2 through the damper 157 and the carrier shaft 127 and motoring of the crankshaft 156 of an engine 150 shall be carried out by the motor MG 1 in each example -- it is good also as a configuration [like]. In the power output unit 210 of this modification, while making a change gear TM into a neutral condition (neutral), by making into an engagement condition the clutch CL 1 attached in planetary gear PG, and a clutch CL 2, it connects with Motor MG through Damper DNP and planetary gear PG, and motoring by Motor MG of the crankshaft CS of Engine EG becomes possible. Therefore, a starting manipulation routine, the engine shutdown manipulation routine of drawing 20 , etc. can be performed at the time of motorised [of a starting manipulation routine or drawing 18] at the time of a halt of drawing 16 explained also with the power output unit 210 of this modification in a starting manipulation routine, the engine shutdown manipulation routine of drawing 15 , and the 2nd example at the time of motorised [of a starting manipulation routine or drawing 11] at the time of a halt of drawing 7 explained in the 1st example. However, in the power output unit 210 of a modification, as mentioned above, some correction is required for application of each above-mentioned routine from hard configurations differing. For example, what is necessary is to replace with step S100 thru/or processing of S106, and just to perform step S400 illustrated to drawing 24 thru/or processing of S406 by application of a starting manipulation routine, at the time of a halt of drawing 7 . Namely, what is necessary is to make a clutch CL 1 and a clutch CL 2 into an engagement condition (step S401), to set the predetermined torque TST for motoring as torque command value Tm* of (step S402) and Motor MG, after setting the closing motion timing of an inlet valve as the predetermined timing by the side of a lag (step S404), and just to control Motor MG, while making a change gear TM into a neutral condition first (step S400).

[0111] Moreover, it can have the resonance judging circuit 200 illustrated to drawing 21 also with the power output unit 210 of such a modification, or the resonance judging manipulation routine illustrated to drawing 22 can also be performed.

[0112] Thus, since you may be what kind of configuration as long as the engine crankshaft is mechanically connected to the motor through the damper in this invention, it is good like the power output unit 310 of the modification illustrated to drawing 25 also as a configuration in which the crankshaft CS of Engine EG is connected to the direct motor MG through Damper DNP.
[0113] As mentioned above, although the gestalt of operation of this invention was explained, as for this invention, it is needless to say that it can carry out with the gestalt which is not limited to the gestalt of such operation at all, and becomes various within limits which do not deviate from the power output unit of an example from the summary of this inventions, such as means of transportation, modes carried in various industrial machines etc. in addition to this, such as a vessel and an aircraft.

[Translation done.]

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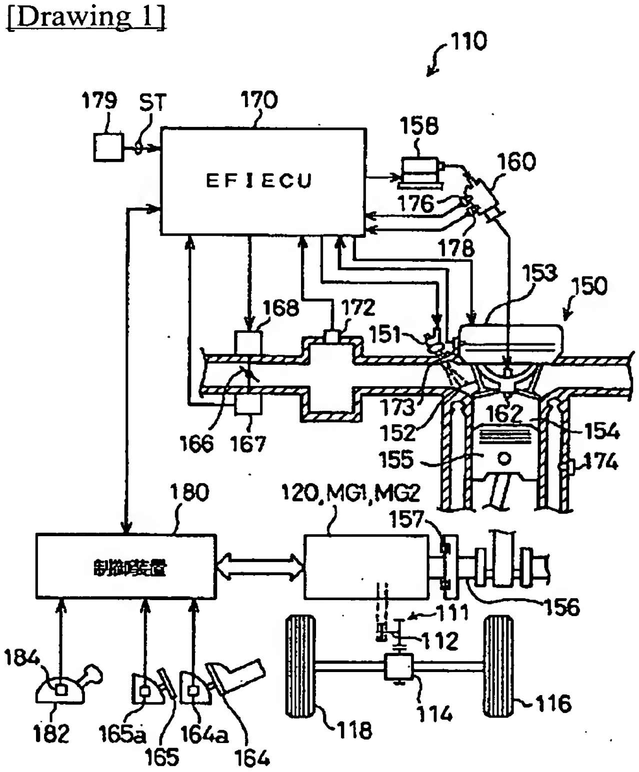
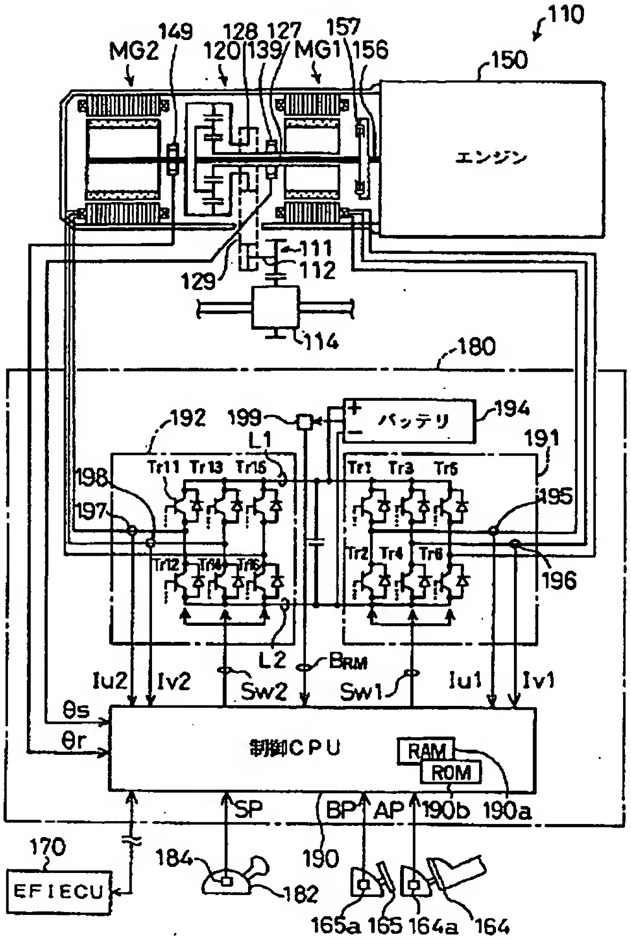
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

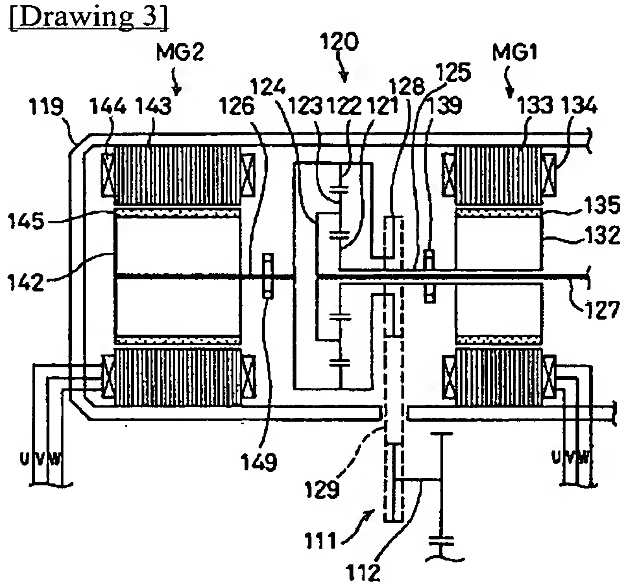
[Drawing 1]



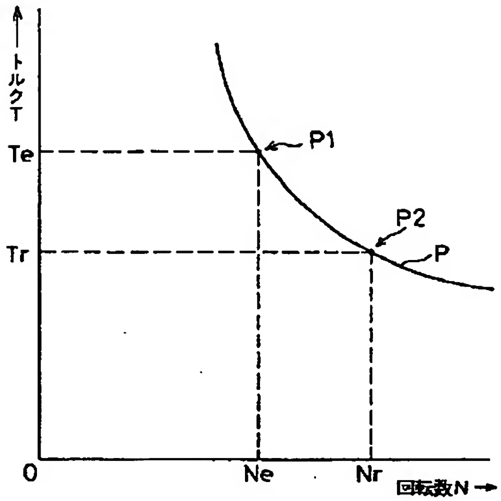
[Drawing 2]



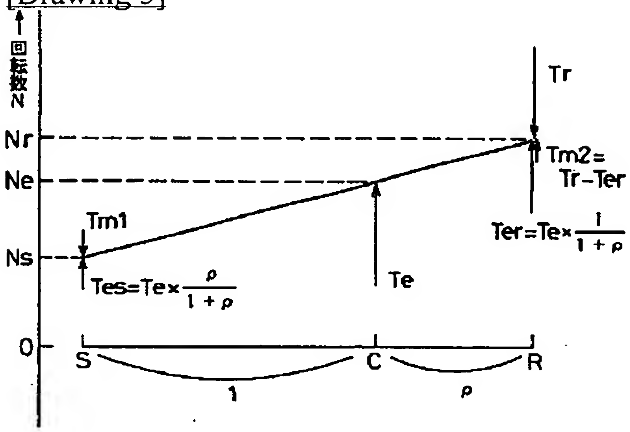
[Drawing 3]



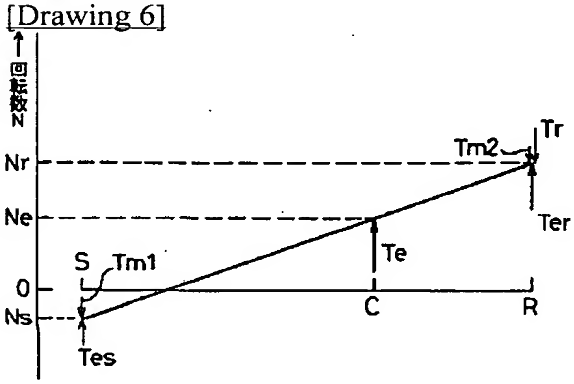
[Drawing 4]



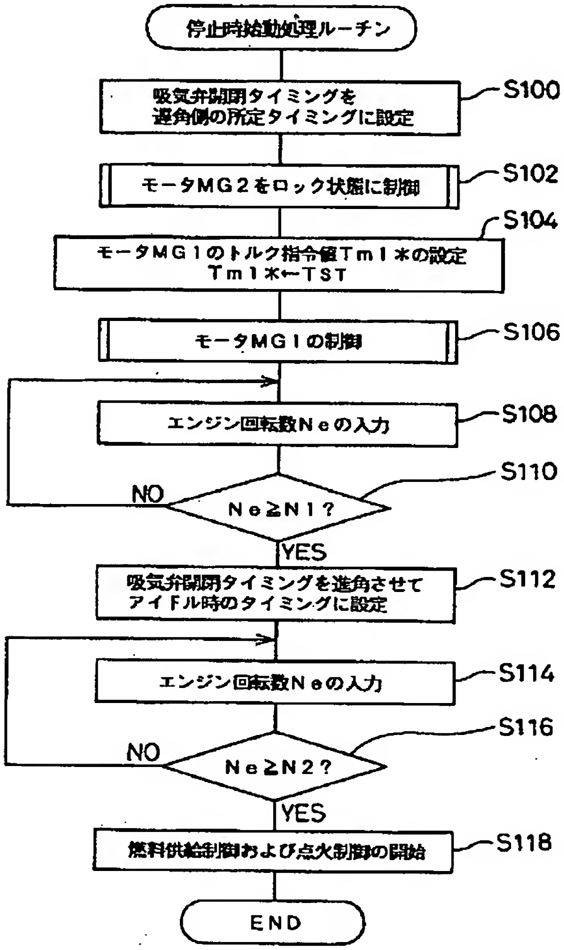
[Drawing 5]



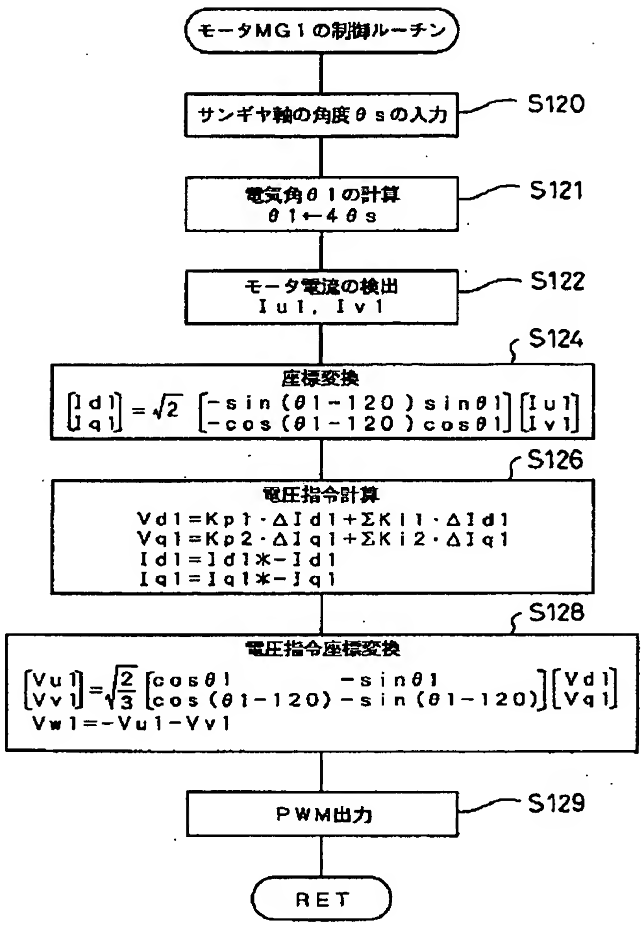
[Drawing 6]



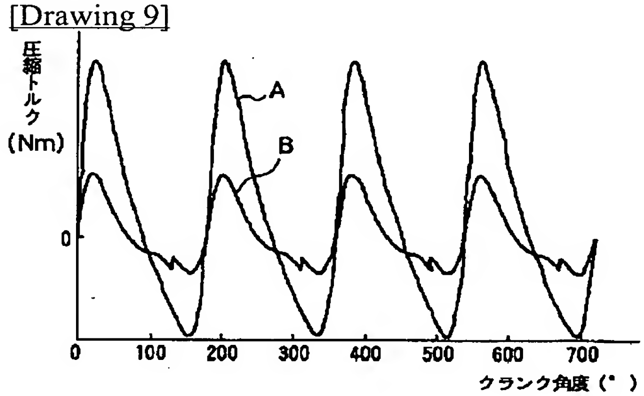
[Drawing 7]


停止時始動処理ルーチン
吸気弁開閉タイミングを
遅角側の所定タイミングに設定
S100
モータMG2をロック状態に制御
S102
S104
モータMG1のトルク指令値Tm1*の設定
Tm1*←TST
モータMG1の制御
S106
エンジン回転数Neの入力
S108
S110
NO
Ne≧N1?
YES
吸気弁開閉タイミングを進角させて
アイドル時のタイミングに設定
S112
エンジン回転数Neの入力
S114
S116
NO
Ne≧N2?
YES
燃料供給制御および点火制御の開始
S118
END

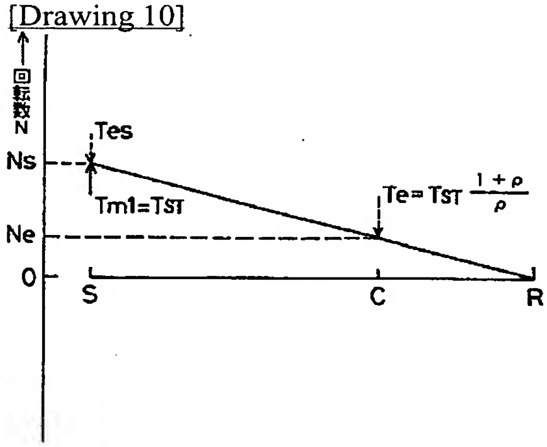
[Drawing 8]



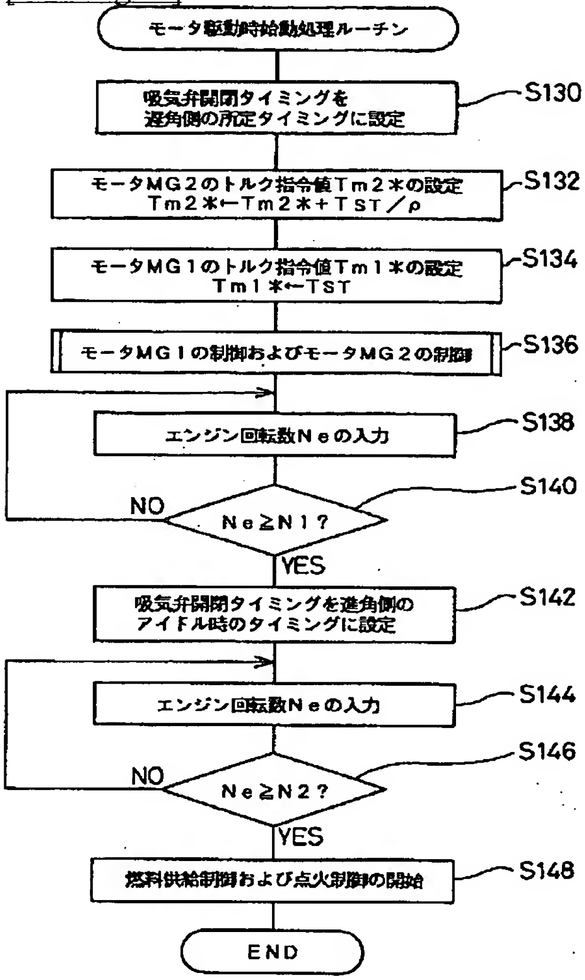
[Drawing 9]



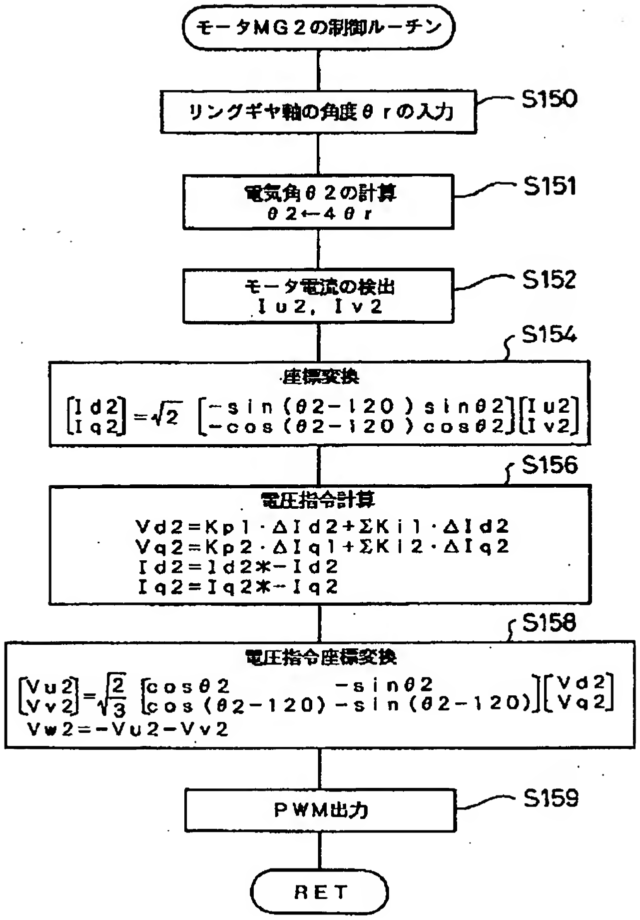
[Drawing 10]



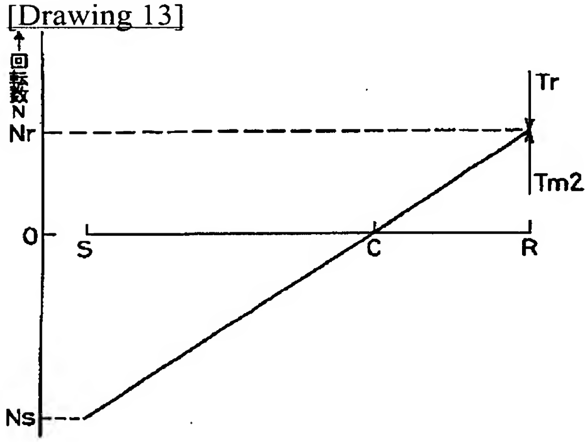
[Drawing 11]



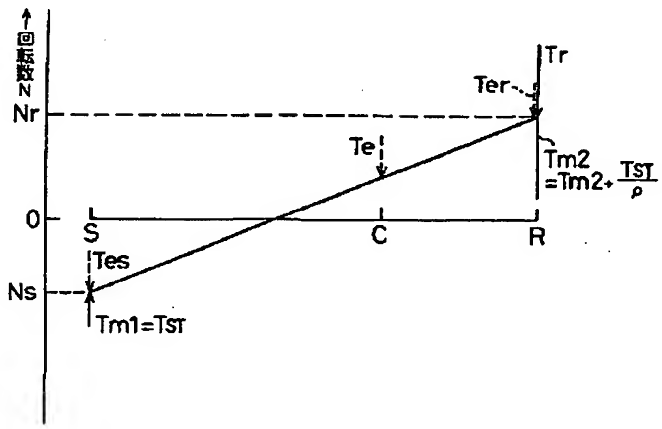
[Drawing 12]



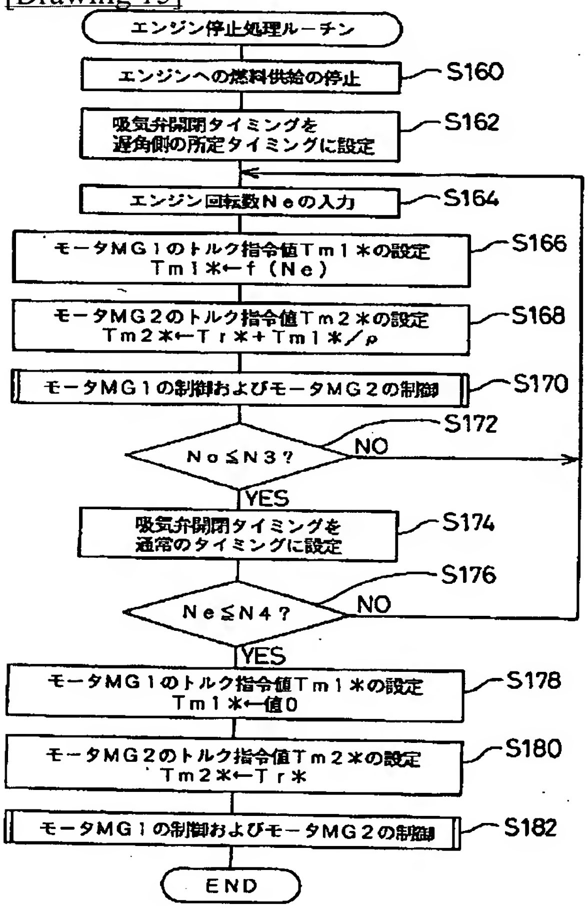
[Drawing 13]



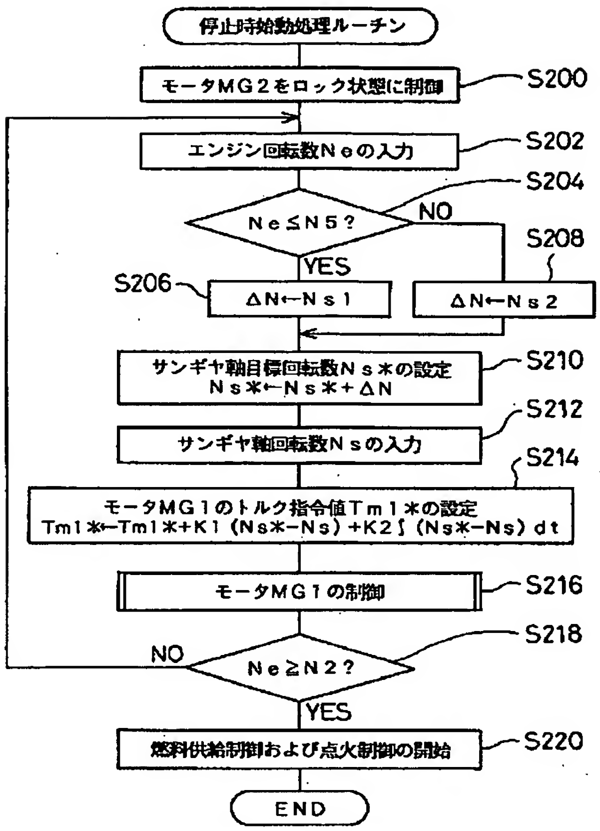
[Drawing 14]



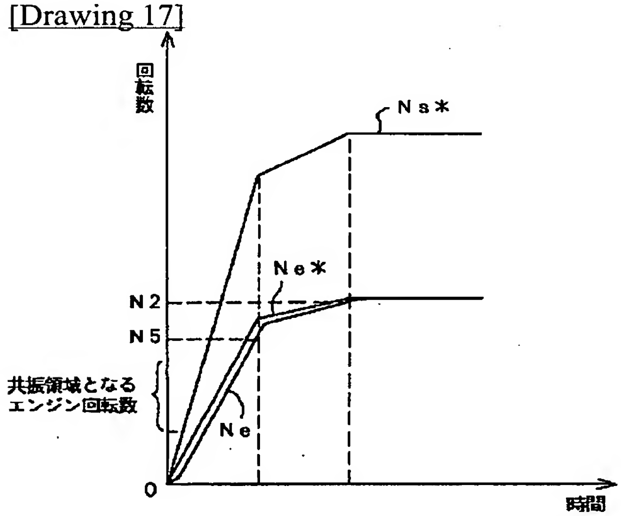
[Drawing 15]



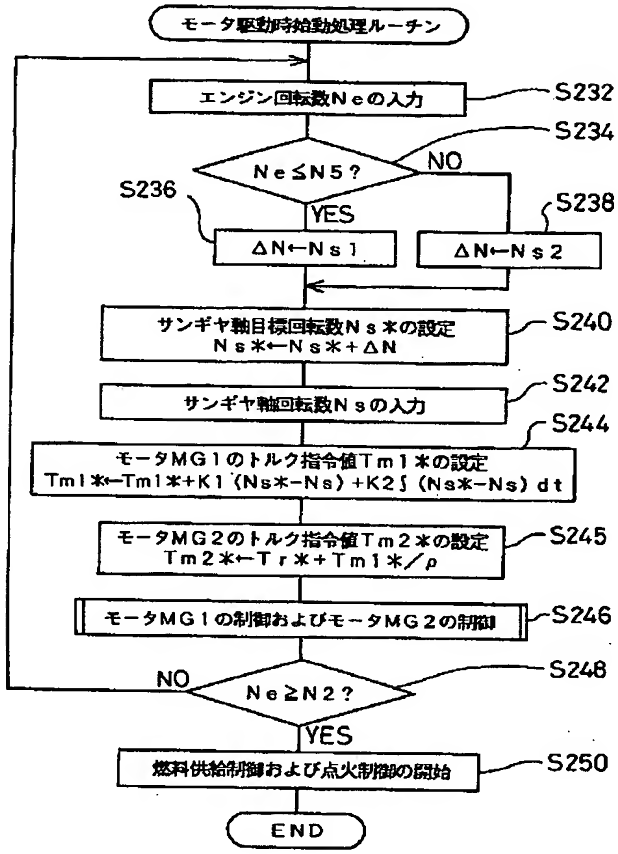
[Drawing 16]



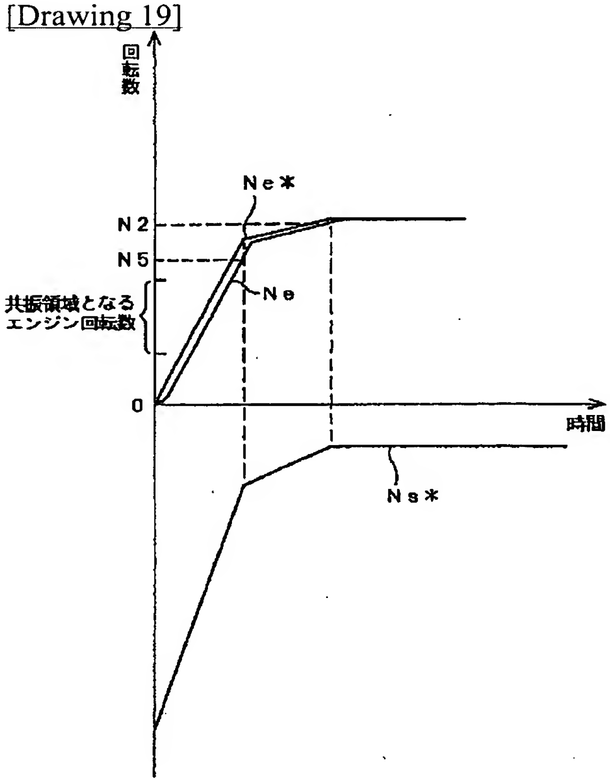
[Drawing 17]



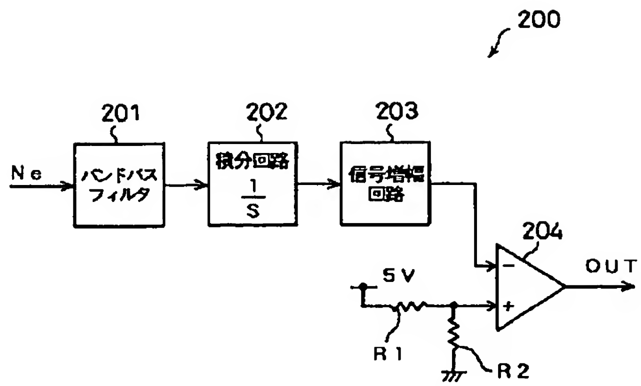
[Drawing 18]



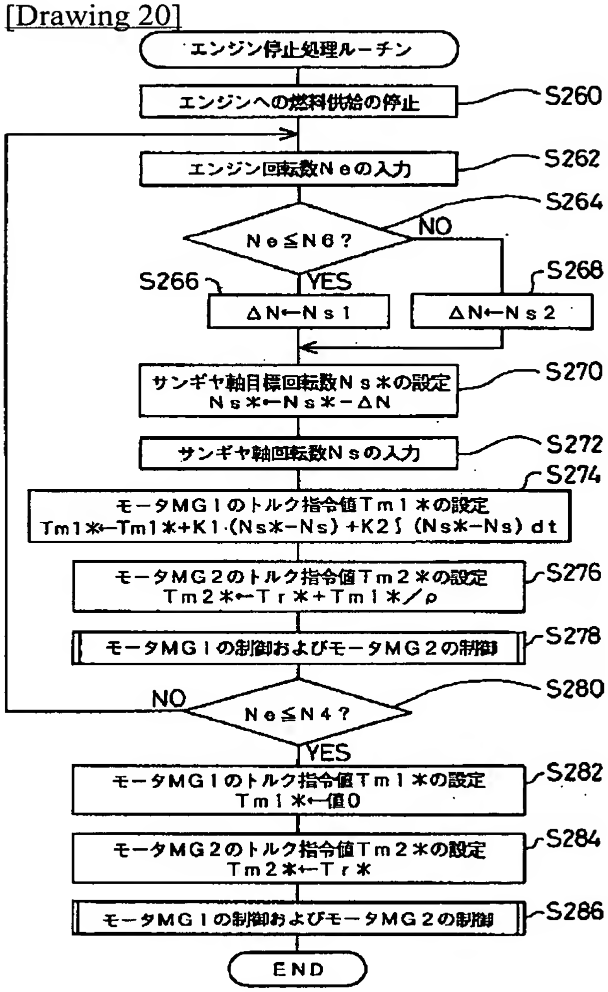
[Drawing 19]



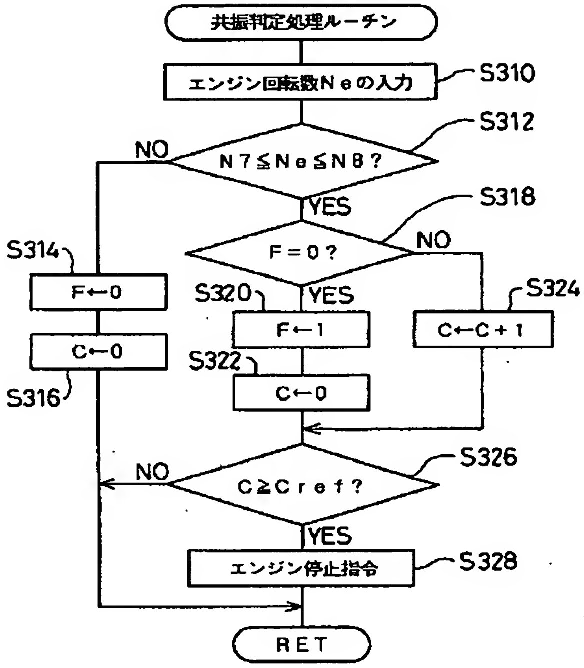
[Drawing 21]



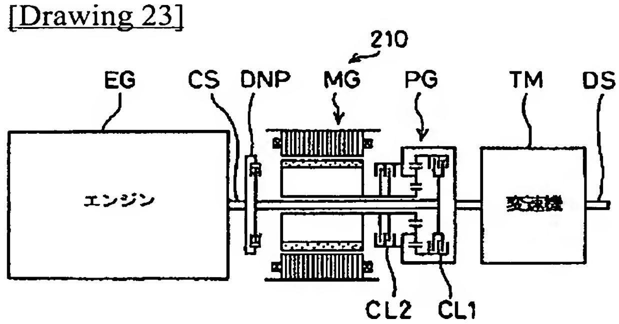
[Drawing 20]



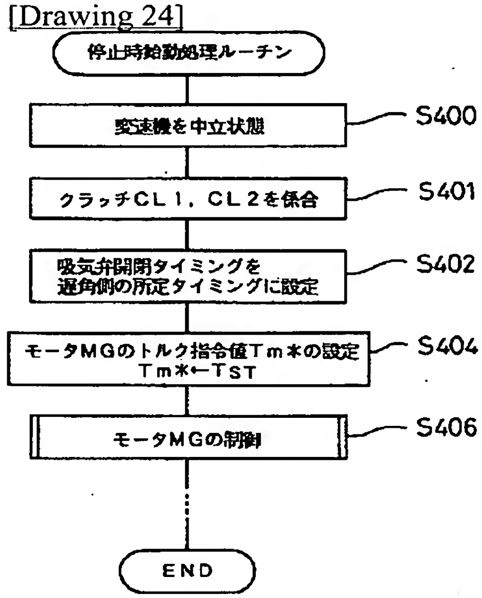
[Drawing 22]



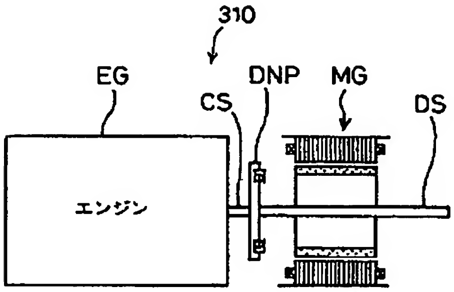
[Drawing 23]



[Drawing 24]



[Drawing 25]



[Translation done.]